MAR 13 1931

MARCH 1931

MACHINE DESIGN

AS IT AFFECTS

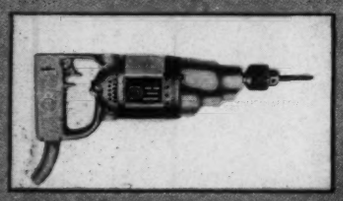
ENGINEERING—PRODUCTION—SALES

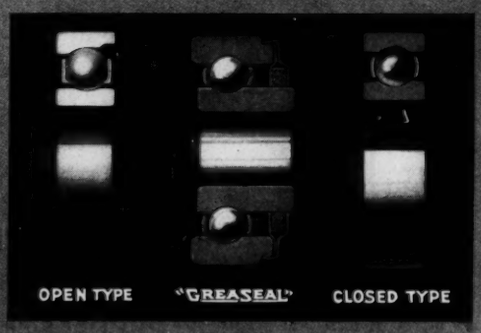
SINCE 1918

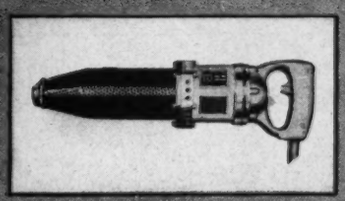
USED IN

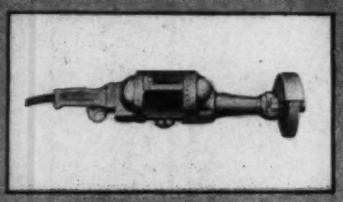
BLACK & DECKER

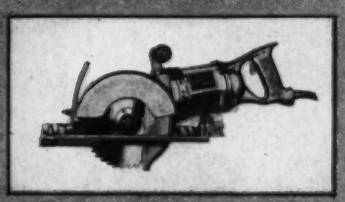
HIGH SPEED PORTABLE TOOLS

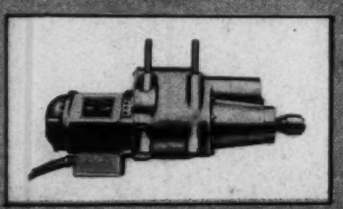


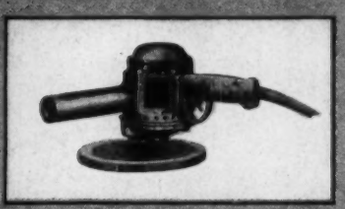


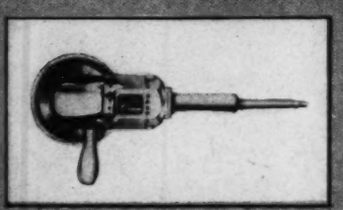


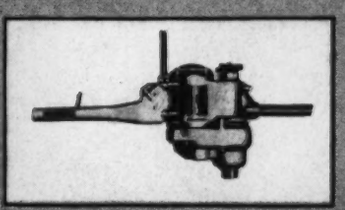


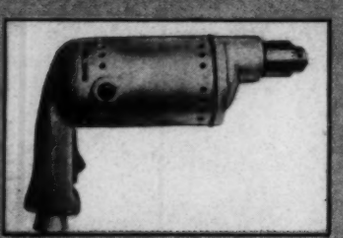


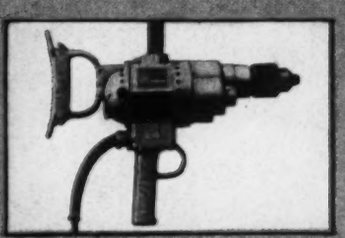












BLACK AND DECKER Mfg. Co. (Towson, Md.) produce a line of portable tools that is unrivaled in scope and in the diversity of duties it covers.

The extensive use of NORMA-HOFFMANN Precision Bearings in this comprehensive and diverse line, proves the wide range of adaptability for all duties afforded in the many types of PRECISION Bearings.

In Black and Decker tools, NORMA-HOFFMANN Bearings are carrying their loads at speeds ranging (according to location) from 200 R. P. M. to 14,000 R. P. M. They are used on chuck spindles, intermediate shafts, and motor shafts.

Wherever the worth of a tool or machine is measured by its service-ability, the use of NORMA-HOFFMANN Bearings will effect a definite and tangible betterment in its performance.

There is a PRECISION Bearing for every load, speed and duty. Our Catalogs will aid you in making selection. Write for them — or ask our engineers.

"NORMA-HOFFMANN"

PRECISION BEARINGS

BALL, ROLLER AND THRUST

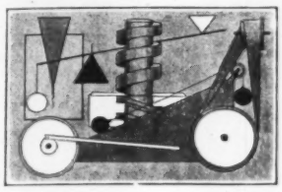
NORMA-HOFFMANN BEARINGS CORPN.—STAMFORD CONN. U.S.A.

MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 3 **March, 1931** **Number 3**



Next MONTH

IN THE January issue an article was published on elliptical gearing which aroused considerable interest. Next month it is planned to include another contribution by the same author, dealing with elliptical gear substitutes. Many interesting methods for obtaining similar results are treated.

Among other articles scheduled for April is one on application of steel castings, written by a leading authority in this line. The field for steel castings continues to grow, and this contribution therefore is timely and valuable, particularly as it presents the most up-to-date aspects of the subject.

L. E. Jermy
Managing Editor

CONTENTS

	Page
Will Criticism of Machine Age Retard Design Activity?	**23**
Scanning the Field for Ideas	**26**
Calculating Stresses in Hooks and Curved Bars *By C. H. Kent*	**30**
Record Breaking Blue Bird Embodies Unique Design Features *By A. M. Wolf*	**33**
Defects in Design and Tooling of Bearings *By C. H. Bierbaum*	**37**
Incorporating Standard Units in Machines *By George T. Chapman*	**40**
Die Castings Reduce Machining *By C. R. Maxon*	**42**
Transmitting Torque by Press and Shrink Fits *By J. W. Baugher Jr.*	**45**
Photoelectric Cell Units—Application and Design *By Edgar H. Felix*	**47**
Professional Viewpoints	**50**
To Design for Specific Market Is Good Business Policy (Editorial)	**52**
Design Progress in Domestic Sewing Machines	**53**
Noteworthy Patents	**54**
Men of Machines	**56**
Obituaries	**58**
Topics of the Month	**59**
How Is Business?	**62**
New Materials and Parts	**66**
Manufacturers Publications	**82**
Business and Sales Briefs	**86**
Calendar of Meetings and Expositions	**20**

Published on the fifteenth of each month by

THE JOHNSON PUBLISHING CO., PENTON BUILDING, CLEVELAND, O.

in affiliation with The Penton Publishing Co.

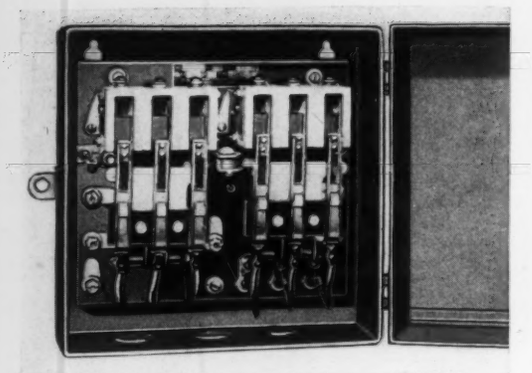
FRANKLIN H. JOHNSON, Publisher; L. E. JERMY, Managing Editor; W. C. KREMSER, Circulation Manager; H. B. VEITH, Editorial Representative; HOWARD H. DREYER, Western District Manager, 1347 Peoples Gas Building, Chicago; Penton Publishing Co. Ltd., Caxton House, Westminster, London, S. W. 1, European Representative

Subscription rates: United States and Canada, two years, $5.00; one year $3.00. Europe, two years, £1.13.6; one year, £1. Single copies, 35 cents.

Copyright, 1931, by The Johnson Publishing Co., Penton Building, Cleveland. All rights reserved.

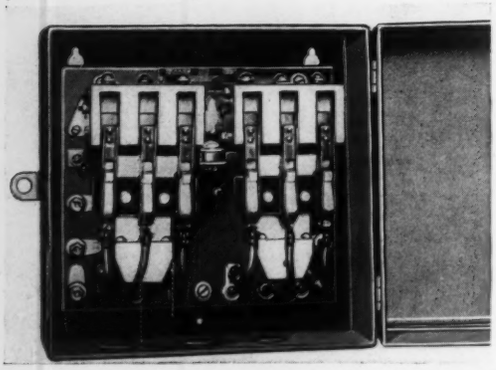
For Tool Builders . . .

Monitor has standardized a.c. *and* d.c. *installations*



A. C. Across-the-line Magnetic Reversing Starter

<·>



D. C. Across-the-line Magnetic Reversing Starter

TO facilitate quick delivery and simplify assembly, Monitor has standardized cabinets, control stations, and control wiring for both a. c. and d. c.

Each tool can be assembled with cabinet and control stations and the wiring between station and cabinet installed. Later, when definite power specifications are made, all that need be done is to insert the right controller (a. c. or d. c.) and run wires to the motor.

This is one of the many advantages of Monitor standard parts that make it possible to produce custom-built controllers at regular prices.

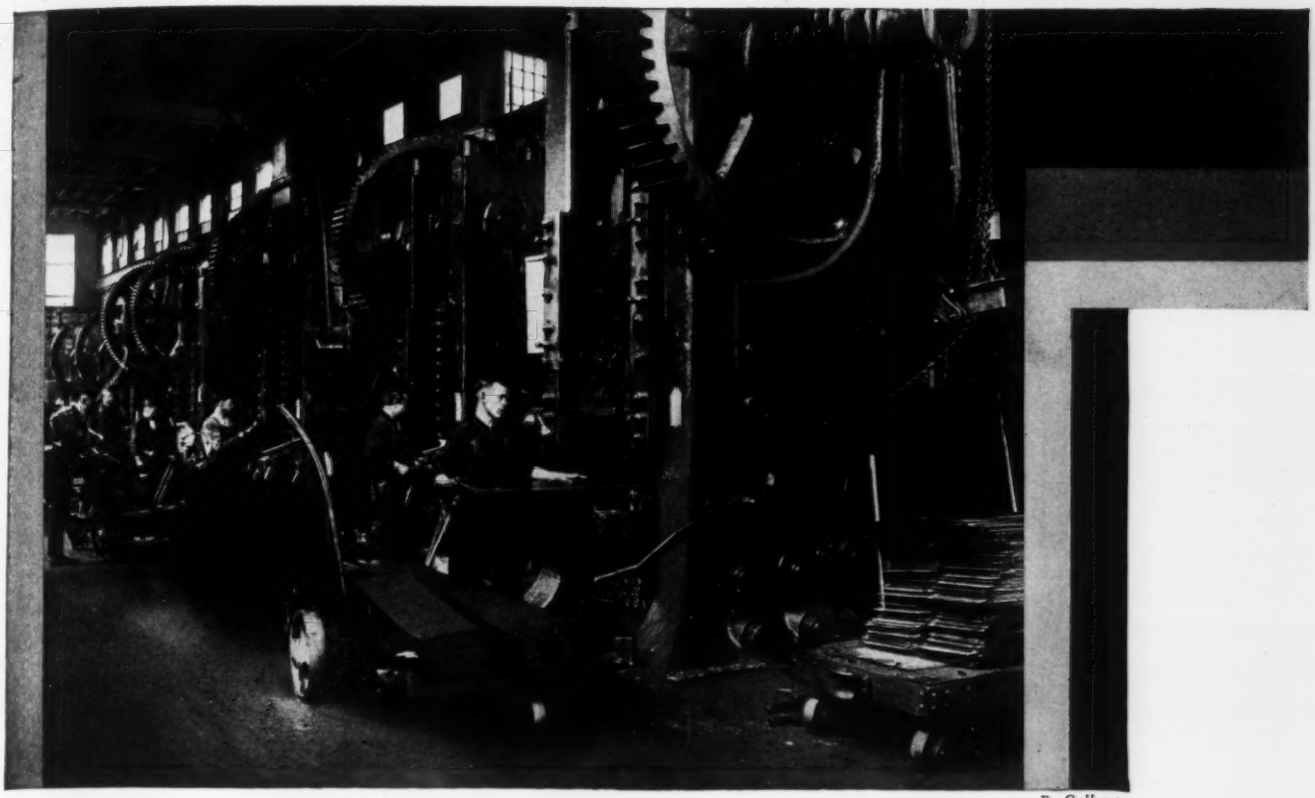
For descriptive bulletins, write your name and address on margin of page below, tear off and send to

MONITOR CONTROLLER COMPANY
Gay, Lombard and Frederick Streets, Baltimore, Md.

IF YOU HAVE A CONTROL PROBLEM . . . CONSULT MONITOR

Monitor *does it automatically*

SEND BULLETINS 5755-F . . . FH and 7003-F, 7005-F to _____
82-6832-1 MD-331.



E. Galloway

Alloy Steel Eliminates Dead Weight

REDUCTION of weight, without sacrifice of strength, rigidity or stamina, is one of the decided benefits accruing to industry through the use of Alloy Steel and Iron.

This benefit is manifold—transportation and handling costs are lower—equipment is easier to install and maintain—more producing units can be placed on floors limited to carry restricted loads—friction is reduced—higher speeds are made possible—less power is consumed—operating costs are lower.

The skillful use of Ferro-Alloys in Alloy Steels and Irons provides the increased purity, density, tensile strength and resistance to abrasion, impact, distortion and fatigue, necessary to the elimination of dead weight.

Electromet engineers will gladly explain how lightness in equipment can be achieved by the use of Ferro-Alloys.

ELECTRO METALLURGICAL SALES CORP.

Unit of Union Carbide UCC *and Carbon Corporation*

Carbide and Carbon Building, 30 East 42nd Street
New York, N. Y.

Electromet
Ferro-Alloys & Metals

CALENDAR OF MEETINGS AND EXPOSITIONS

March 16-22—Oil Equipment and Engineering Exposition. A technical and scientific gathering of latest developments in machinery and instruments of the oil industry to be held in Los Angeles. Various technical societies are planning meetings in connection with the exposition. These include the American Society of Mechanical Engineers, the American Institute of Mining and Metallurgical Engineers, the American Petroleum institute, also the California Natural Gas association, California Meter association, and western division of the American Welding society. This will be the only big oil exposition held in the United States during 1931. In addition to indoor exhibits of equipment, there will be derricks and large displays of operating machinery out-of-doors. Actual drilling will be conducted under various conditions with different types of drilling rigs. Special fire prevention equipment will be demonstrated on large tanks and structures. E. G. Lenzner, Box 781, Vernon station, Los Angeles, is manager of the affair.

April 12-16—American Society of Mechanical Engineers. Joint national meeting of the materials handling and management division to be held in Cleveland at the time of the industrial equipment exposition. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

April 13-18—Second National Industrial Equipment Exposition. To be held at the public auditorium, Cleveland. G. E. Pfisterer, 308 West Washington street, Chicago, is managing director.

April 13-18—American Oil Burner association. Eighth annual convention and oil burner show to be held in Benjamin Franklin hotel, Philadelphia. Harry F. Tapp, 342 Madison avenue, New York is executive secretary of the association.

April 20-23—American Society of Mechanical Engineers. Semiannual meeting at Birmingham, Ala. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

April 22-24—American Welding Society. Annual meeting in New York. M. M. Kelly, 33 West Thirty-ninth street, New York, is secretary of the society.

May 4-8—American Foundrymen's association. 1931 annual convention and exhibition to be held at Stevens hotel, Chicago. C. E. Hoyt, 222 West Adams street, Chicago, is secretary of the organization.

May 4-9—Exposition of Chemical Industries. Machinery, metals and alloys, chemical products, etc., will be included in the 40 or more exhibits of this thirteenth exposition to be held at Grand Central Palace, New York.

May 6-8—American Society of Refrigerating Engineers. Spring meeting at Hotel President, Kansas City, Mo. David L. Fiske, 37 West Thirty-ninth street, New York, is secretary of the organization.

May 7-9—American Gear Manufacturers' association. Annual spring meeting to be held at Hotel Statler, Buffalo. T. W. Owen, 3608 Euclid avenue, Cleveland, is secretary.

May 11-15—American Mining Congress. Eighth annual convention to be held at Cincinnati. At the same time a national exposition of mining machinery and equipment will be conducted.

May 12-14—American Society of Mechanical Engineers. National Aeronautic meeting, Baltimore. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary.

June 8-12—National Electric Light association. Fifty-fourth convention and exposition to be held at the municipal auditorium, Atlantic City, N. J. Frank H. Gale, 420 Lexington avenue, New York, is secretary-treasurer.

June 15-16—American Society of Mechanical Engineers. National applied mechanics meeting at Purdue university, Lafayette, Ind. Calvin W. Rice, 29 West Thirty-ninth street, New York, is secretary of the society.

June 15-18—American Society of Mechanical Engineers. Fourth National Oil and Gas Power meeting to be held at the University of Wisconsin at Madison. E. J. Kates, secretary of the division, has announced that the technical program of the meeting would be arranged by Julius Kuttner, editor of *Diesel Power*, in co-operation with Professors G. L. Larson and B. G. Elliott of the university.

June 22-26—American Society for Testing Materials. Annual meeting at Stevens hotel, Chicago. C. L. Warwick is secretary.

June 22-26—American Institute of Electrical Engineers. Annual summer convention to be held at Asheville, N. C. F. L. Hutchinson, 33 West Thirty-ninth street, New York, is secretary of the organization.

MACHINE DESIGN
THE JOHNSON PUBLISHING COMPANY, CLEVELAND, OHIO
March, 1931 Vol. 3—No. 3

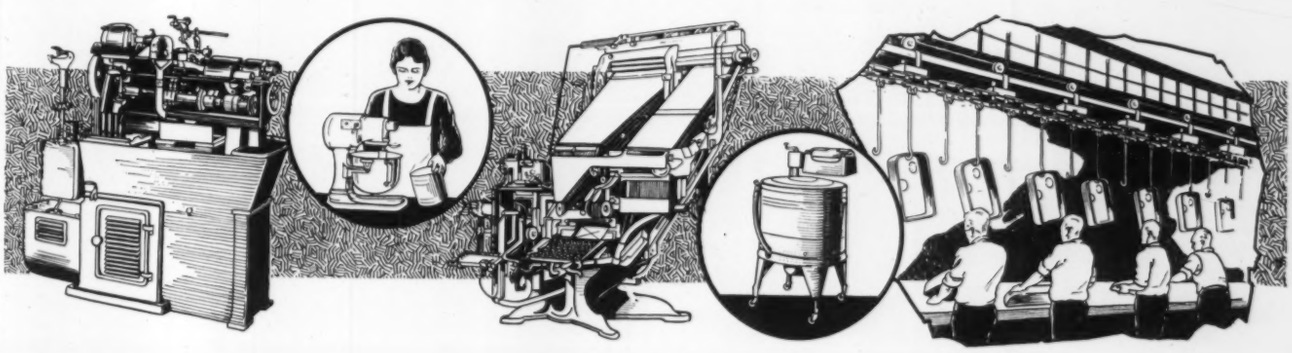
Will Criticisms on Machine Age Retard Design Activity?

WHAT is the answer to the criticisms on this machine age? It is agreed almost unconditionally that advancement in civilization and standards of living has been the direct result of progress in development of machinery. This symposium presents ten authoritative views.

DESIGN and development of new machinery continues at a steady pace as the trend of industrial activity points toward further mechanization. Here and there among the laity are signs of alarm, but engineers seem to harbor no anxiety as to the outlook of the machine age. They stand ready to cope with the problems technically and sociologically.

Delving into the past it readily can be seen that additional problems began to arise with the invention of early machines. But withal the word machinery is synonomous with progress and is the means whereby civilization has advanced to a high plane of culture. Machinery has provided the tools with which humanity has lifted itself from the barbaric stages to a better existence and has opened the way to education and prosperity.

In the evolution of present day high production machines from the crude devices employed by the savage, chaos and riot were rife. The industrial revolution more than a century ago was one of the turbulent eras that marked the course of machine progress. Workers became incensed and adherents of the old order took up arms against the mechanical instrument. They



felt is was divesting them of their rights.

Forward thinking men, however, stood for the machine and normal conditions were reestablished. A better working environment was provided in the factories and a period of tranquility followed. It was evident that machinery was an asset rather than a liability and did not work a hardship on men when properly organized.

During the war the world was engaged too busily with its problems to give much thought to effects of machines on men; capacity for production was more important. With the close of the conflict a period of reconstruction ensued. Depressions brought unemployment and once again minds were turned towards machines, though sometimes in a skeptical light.

Much is being said at the present time and criticism in both directions is included in the discussions. Unemployment, in particular, has received attention with a view toward fixing the blame. The machine, however, is not to be condemned. Unemployment is the result of failure to adjust conditions to the new order of things, which when finally comprehended will end in even greater advancement in our social and economic structure.

Solution of the problem is seen by Dr. Harvey N. Davis, president of Stevens Institute of Technology, who has this to say about the situation: "There is another unemployment problem with which engineers are not only intimately concerned, but worse than that, for which they primarily are blamed. That is the problem of so-called 'technological unemployment'—that is, replacement of men by machinery. I have no question but that in the long run, through the progress of invention, the mechanization of industry eventually does provide work for more men than it displaces."

I THINK we are fully justified in believing that the activities which have ramified endlessly from the new machine-driven industries —the new jobs that have been brought into being by higher standards of living—should eventually take care of practically all the men and women displaced by the machine.—Dr. Julius Klein, assistant secretary of commerce.

Franklyn Hobbs, director of research, Central Trust Co. of Illinois, Chicago, in a lengthy article published recently draws his conclusion in this wise: "If the condition shown by the bureau of labor report had not been altered by the introduction of machinery during the last 30 years, the factory worker might have found himself at this time in a most unhappy plight.

"It is important that these facts become known as soon as possible by every manufacturer, every stockholder in a factory, and every factory worker in this country. When they are fully realized most of the labor disputes in factories will settle themselves. The labor demagog who rants about machinery causing unemployment then will have to find a small hole, crawl into it, and pull the hole in after him, because actually the machine age has increased employment, increased wages, made work easier, saved lives and limbs, and has enabled the working man to live in comfort and luxury unknown to any man on earth when some of us were born."

In a recent radio address on "A Few Observations on Unemployment," Myron C. Taylor, chairman finance committee, United States Steel Corp., said that the machine age is not a cold-blooded and cruel thing which seeks to exterminate man; it is man's finest expression through which great forces have been revealed to him by the Divine Hand, enabling him so to harness these forces and direct their use that they shall be man's servant and not his master. * * * Triumphant over the whole field of recent mechanical developments stands man, not the machine."

Research in Humanics

Touching upon another aspect of the situation, Dr. Alfred D. Flinn, director of the Engineering Foundation, advocates research in "humanics" and asserts that "It soon must cease to be possible for any person to say or think honestly that the great blessings of science and engineering are even temporarily a curse to himself or anyone else, because of the ways in which they are introduced into industry and business.

"It is not sufficient to aim our researches only at physical applications of the natural sciences. These worthy endeavors must be supplemented by earnest, effective investigations to guide our engineering organizations in helping to solve the grave sociological, governmental and international problems created partly by the achievements of engineers."

Engineering and its relation to economics formed the basis of an address by Ralph E. Flanders, manager, Jones & Lamson Machine Co., Springfield, Vt., before the annual meeting of the American Society of Mechanical Engineers. Paragraphs pertinent to the discussion of the machine age portray Mr. Flanders' outlook on the subject. He says: "This spasmodic and ineffectual interest in the economic problem reflects no credit on modern man. In particular, should we as engineers be dissatisfied with our inability to exercise some measure of control

over the business cycle.

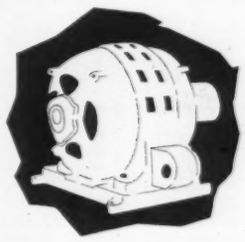
"Until this time we have been led by blind forces. Invention, science, engineering, industrialism, and natural opportunity have combined to lay out a course which we have followed with headlong enthusiasm. This course has led us through a period of unimaginable development, and has brought us social and individual benefits of the material kind to a degree for which we find no parallel in the records of the past. But with these blessings there has come this attending train of problems and perplexities."

Albert Einstein, German physicist, asks why this magnificent applied science which saves work and makes life easier brings us so little happiness? "The simple answer is," he says, "because we have not yet learned to make sensible use of it.

Concern for Man Himself Is Necessary

"It is not enough that you should understand about applied science in order that your work may increase man's blessings. Concern for the man himself and his fate always must form the chief interest of all technical endeavors, concern for the great unsolved problems of the organization of labor, and distribution of goods —in order that the creations of our minds shall be a blessing and not a curse to mankind. Never forget this in the midst of your diagrams and equations," he warned the several hundred students of the California Institute of Technology, to whom he was speaking.

Former President Coolidge enters into the discussion in his copyrighted daily newspaper column. He contends that "extending the use of machinery always has made it difficult for the short-sighted to reconcile the interests of groups immediately affected with the interest of society. One of the fundamental reasons for this is the misleading name that has been given to the introduction of mechanical devices for doing work. We call it labor-saving machinery; in reality it is labor making.



"The machine by increasing the productive power of the workman, raises his wages and standard of living. Transferring and absorbing displaced wage earners with the least possible loss in a problem industry must solve. Concerns and countries that fail to adopt the most modern machinery have the least work and the lowest pay for the wage earners. It only is modern equipment that promises the most work and the highest wages."

Aside from the effects of the machine age and its relation to unemployment, there remains the reason why the engineer has had to bear the brunt of the criticism. Conrad Matchoss, director, Verein Deutscher Ingenieure, Berlin, Germany, gave a good explanation of this point in his address at the fiftieth anniversary celebration of the American Society of Mechanical Engineers. He said in part: "In the last few centuries the engineer, more than any other, has contributed to the remodeling of the whole of human existence. It therefore is readily understandable that, having such a powerful influence on his fellows, he lays himself and his work open to criticism.

FOR every man displaced by machine, two new jobs are created, probably more. We are too prone to forget that even in days of maximum depression some four million men were at work in our automotive industry alone, and these four million jobs are new jobs created by mechanization during the past thirty years.—Prof. John Younger, professor, industrial engineering, Ohio State University.

"We who in our own lives feel more and more distinctly the far-reaching effects of the great technical revolution, which began with the invention of the steam engine, are also greatly exposed to this criticism today. During the last two centuries enormous quantities of printer's ink have been used and whole libraries have been written to damn engineering from top to bottom and to make it responsible for all the unhappiness of life, or else to praise it as the deliverer and savior from all evil. But engineering, with its most characteristic symbol of the present age, the engine, is far beyond good and evil, and its development passes over praise and blame without leaving a trace.

"We engineers—and this attitude is based on our work and on our love for our profession—will rank ourselves among the born optimists. We refuse to believe in the decline of the world—we believe rather in the great future which is in store for mankind. We want to form a single creative will, uniting with all the peoples of the earth of the same mind, and with all professions."

From the foregoing authoritative views it is evident that the consensus of opinion points to the necessity for rapid adjustment being made as and when developments are introduced. It is inevitable that advancement in engineering and design of machinery will continue at an ever increasing pace. And one of the strongest arguments in favor of this is that many of the innovations do not displace man power but rather create labor by the strengthening of old established lines of business or by the introduction of entirely new industries.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

INTENSIVE activity in the pipe line field is providing the opportunity for development of many unique types of equipment. In an industry of more or less mushroom growth the ingenuity of engineers and designers often is taxed to the utmost to furnish satisfactory devices for overcoming difficulties not previously foreseen. And the engineer who is able to adopt and apply ideas gleaned from his knowledge of equipment used in other branches of industry, or from his experience in his own, is in an advantageous position.

A machine for applying protective covering spirally to underground piping used in carrying and distributing oil or natural gas has been developed for field use. It is logical that spiral wrapping should be resorted to, inasmuch as spiral bending of pipe for pipe line work and other applications has been developed for some time and machines also are being used for spiral welding. The protective material is bituminous felted fabric, wrapped spirally around the pipe. The wrapping machine, shown in Fig. 1 and 2, is portable and thus can be operated in a central yard or taken to the site of the line. This obviates the shipment of covered pipe for long distances with the possibility of abrasions en route.

The uncemented fabric is received at the machine in roll form. From the rolls the fabric is drawn over idler rollers and through the bath of heated cementing material by the rotating and forward movement of the pipe. The tension under which the covering is applied precludes the presence of loose pockets between pipe and covering, as frequently occurred when other methods were used in earlier attempts to solve this problem.

It will be noted from the illustrations that the machine is comparatively simple in design and construction, but in it are to be found evidences of the influences of machines used for spiral wrapping in other fields of engineering. The pipe wrapping mechanism is not radically different from the portable machines which wrap the outer covering of wire on the cables of long suspension bridges.

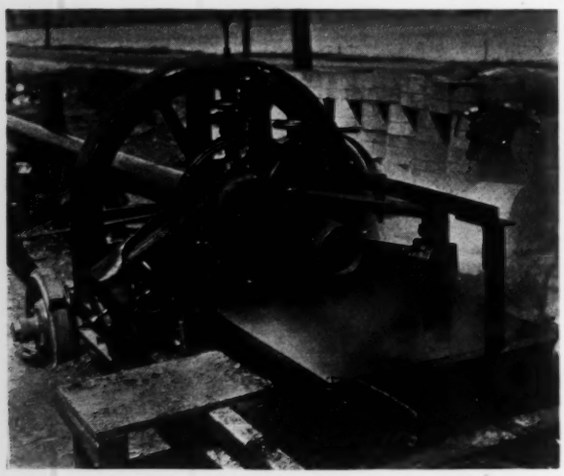


Fig. 1—Pipe covering machine at work. Uncemented fabric roll at right

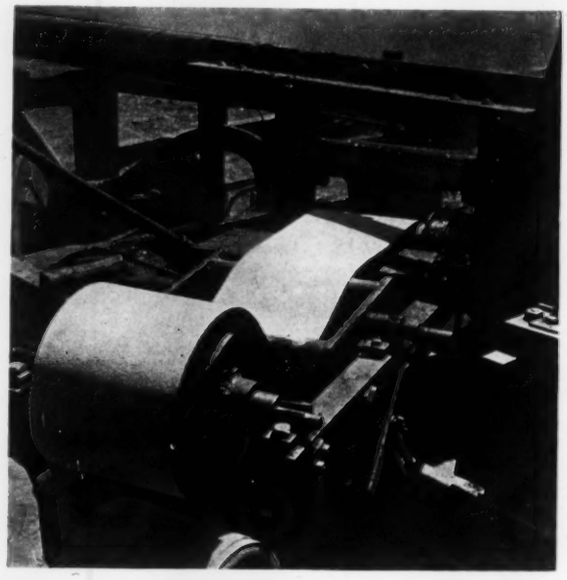


Fig. 2—Fabric feeding attachment from which covering is drawn

Electronics to the Fore

ELECTRONIC devices are playing an increasingly important part in machinery and equipment, and it will repay engineers in

charge of design to follow closely the developments of these units. On page 47 of this issue of MACHINE DESIGN appears the second section of a contribution on photoelectric equipment, in which electron tubes are used.

Another application of electronic apparatus is shown in Fig. 3. This depicts a device known as the stroboglow being used to study the behavior of a single commutator bar with the motor running at full speed. The equipment was developed in the research laboratories of the Westinghouse Electric & Mfg. Co., and is intended for making rotating or vibrating machinery appear stationary during observation of the parts.

Fig. 3—Stroboglow used for studying commutator bars in rotating motor

With this apparatus, beams of light flashing on and off in synchronism with the moving part, are focused upon it, and form a stationary image. The rapid flashing of the light is actuated by the quick charge and discharge of the grid glow tubes. Comprising the stroboglow set are two parts, a large case containing the foundation unit with three reflector units, the mechanical timer and the necessary tubes; in a smaller case the electrical timer is carried.

Studying Vibrations of Parts

SERVING a purpose similar to the stroboglow, referred to in the foregoing, and indicative of the interest of engineers in the observation of moving machine parts, is a new form of stroboscope developed by H. E. Edgerton, a member of the technological and research staff of the Massachusetts Institute of Technology. It is said that in a motion picture taken of the rotor of motor running at a speed corresponding to a ground speed of 95 miles per hour, every detail of the moving parts was shown as clearly as if the machine had been standing still. Photographic exposures with the new instrument can be made at ten one-millionths of a second.

These instruments for observing the operation of moving or vibrating parts call to mind an older device, the vibroscope, with which it is possible not only to find the location of static and dynamic unbalance but to record the amount. Fig. 4 shows the method employed in finding the "high spot" of an unbalanced unit.

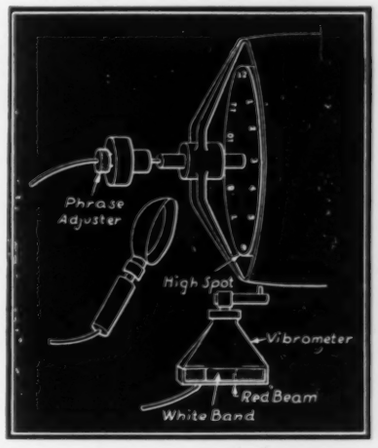


Fig. 4—Showing how the portable vibroscope is applied to part to be balanced. Amount of unbalance is indicated in the vibrometer and location is determined from a marked revolving part

Suggests Rubber for Auto Doors

A REVOLUTIONARY idea, and yet one with far reaching possibilities, was proposed in a comment on a paper presented at the recent annual meeting of the Society of Automotive Engineers. In this comment it was suggested that molded rubber doors for automobiles would be an economical proposition; the universal use of closed cars with flexible, nonsqueaking doors indicating the need for a nonmetallic substance for this purpose. Doors could be made, it was mentioned, to allow for the molding-in of screw attachments for metal parts. Thus locks, etc., could be molded in place.

Adoption of this idea if found practicable, would result in a tremendous increase in the demand for rubber in the automotive industry. Already, according to R. K. Lee of the Chrysler Corp., there are 650 different rubber parts incorporated in the Chrysler line of cars. Eight per cent of the total cost and 3.8 per cent of the weight of a Chrysler 8-cylinder sedan is made of rubber. Mechanical rubber goods in the car weigh 38 pounds, and only the high cost of molds for making rubber parts, Mr. Lee claims, has prevented a wider use of this material.

At another session held during the same meeting of the S. A. E., representatives of the aeronautical staff of Massachusetts Institute of Technology expressed the opinion that the day is

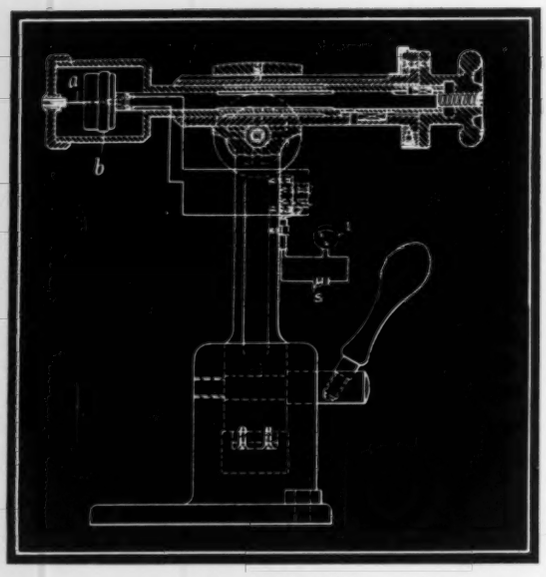


Fig. 5—Recently patented machine for detecting noises in moving parts

not far distant when we shall see fuel injection systems used on aeronautical engines in place of the carburetor. Tests already held indicate striking possibilities for these fuel injection devices.

Noise Detecting Machine Invented

STUDIES of noise created by moving machine parts are particularly useful. This is the case not only from the aspect of "where there's noise, there is wear," but from the humanitarian standpoint. Nerves of operators will remain normal under the strain of noisy surroundings for comparatively short periods. But sooner or later the strain results in inefficient and unproductive efforts to produce satisfactory work.

Employs Movable Coil or Reed

Of timely interest in this connection is a new machine invented by F. W. Highfield, Coventry, England, patented recently in this country. The object of the machine, illustrated in Fig. 5, is to provide simple means for measuring sounds produced by machinery. Incorporated in the unit is an electromagnetic, microphonic or similar device which conveniently can be brought into contact with the mechanism to be tested. A movable coil or reed is placed in the field of the permanent or electromagnet, and to this coil or reed is attached a light needle or style for contact with the work. Any suitable electrical means may be employed for giving a visible indication of the movement of the style.

In Fig. 5, a part sectional elevation of the apparatus, the style is represented by *a*. This is connected to the coil in the case *b* containing the electromagnet. The indicating means are shown diagrammatically in the drawing by battery *s* and the current indicating instrument *t*.

Vibrations due to sound generated within the machinery will be transmitted to the outer case against which the style is caused to bear. These vibrations are transmitted to the microphone or similar device which converts the sounds into an indication on an ammeter or other instrument.

Worn Parts Can Be Located

A portable "electric ear" for a similar purpose to the device referred to in the foregoing has been developed by one of our largest electrical manufacturing companies. This new "ear" fits into an ordinary suitcase and hears noises which are not audible to the human ear. With it the sounds that make up the whirring of rotating machinery can be separated. It is expected that the device will hear loose wrist pins, piston rings, bearings and other parts long before they become badly worn and thus, as in the airplane industry, dangerous.

While on the subject of noise, it is interesting to note that a number of surveys recently have been carried out by the Nielson Co. which indicate the necessity for designing engineers to pay particular attention to this subject. In

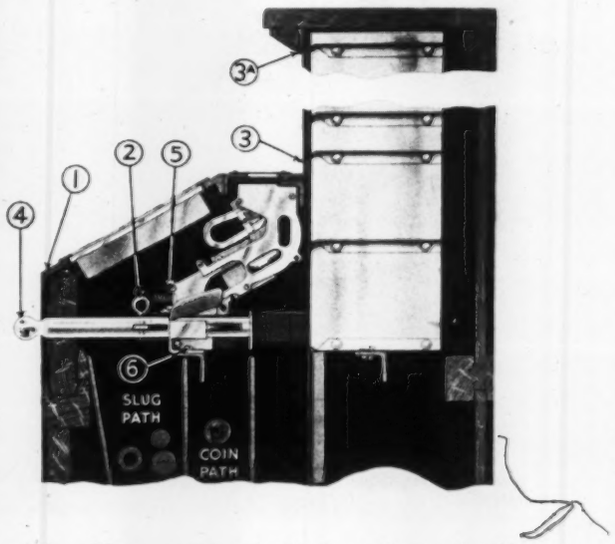


Fig. 6—Slugs are ejected automatically in new grocery dispensing machine

hotels, museums, factories, etc., where engines and fans are installed for refrigerating and air conditioning, it often is difficult to subdue the noise and vibration accentuated in many cases by imperfect design. Results of the surveys show that insulating material such as cork, placed between the operating units and the mounting, serves in many instances to deaden effectively the rumbling and other vibrations. Designers of other types of machinery might

take a tip from this, and in cases where it is impossible or uneconomical to eliminate entirely the noises arising from moving parts, specify insulating material to be placed between the bodies or tables, and the bases of the machines.

Making Welded Units More Graceful

WHILE welded machinery necessarily does not embody the graceful lines inherent in units built up from castings it is being proved almost daily that vast improvement is possible over the early attempts in designing for welding. Fig. 7 is a case in point.

The one-half horsepower Westinghouse motor shown was developed for welded construction. Design of the frame, however, followed the working out of models in clay in the endeavor to obtain distinctive appearance, an idea which readily could be carried out in the case of many other small machine units or assemblies. The instinctive feeling of distaste in the minds of engineers to units of ungraceful appearance may take some time to live down. It therefore seems incumbent on designers to make the most of the trend toward welded construction by considering not only the stresses in the structure but also the final appearance.

Watch the Coin Machine Market!

IMMENSE opportunities are opening up for automatic coin-in-slot machinery. For some years it has been possible to obtain a cup of coffee, roll and butter, pie, etc., by dropping nickels in slots in "automat" restaurants. And now one may obtain all the requirements for a meal, even to meat and vegetables, from portable automatic slot machines placed in the hallways of apartments or other suitable locations.

In these new electrically operated units the food purchased is on display with the price marked beneath the display window. If the cost of the commodity is an odd amount, change is proffered by the machine, and rapid strides are being made in the development of change making units which eventually will obviate abuse.

Fig. 7—This motor frame disproves theory that welded units cannot be made graceful in appearance

In Fig. 6 is shown a section of one of the compartments of the machine built by National Sales Machine Co., St. Louis which shows also the slug rejector. Slugs containing magnetic material as well as washers of any material are ejected at point 5, while legitimate coins are discharged into the box for money at 6.

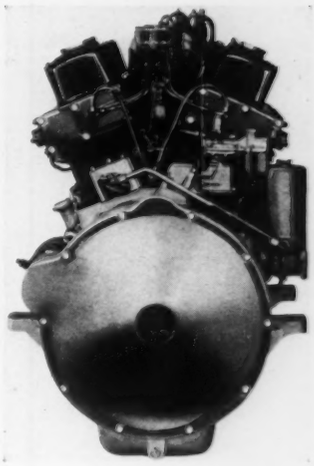


Fig. 8—An angle of 45 degrees is used between banks of cylinders on the latest engines. This, and the placing of carburetors between the banks, assures extremely compact design

It is not unlikely that we shortly will see automatic coin machines for rail ticket vending, change making, gasoline dispensing, newspaper and magazine selling and numerous other purposes, in general use.

Compactness Is Asset in Design

COMPACTNESS of design is well illustrated in the power boat engine shown in Fig. 8. This is a 12-cylinder model built by Kermath Mfg. Co., Detroit, with a rating of 145 horsepower. Overall length is only 55¼-inch and with the two banks of six cylinder blocks set at a 45 degree angle, the total width is practically the same as the average six-cylinder engine of about one-half the horsepower. The carburetors are placed within the cylinder banks.

The 45 degree angle between banks is gaining rapidly in popularity on the larger gasoline engines. Though slightly uneven firing results, equal spacing being obtainable on engines with banks set at 90 degrees, there is considerable saving in overall width and the uneven firing assists in reducing to some extent the torsional vibration of the crankshaft.

Every day brings to light a new machine, engine or other mechanical unit designed for full capacity but reduced in size from earlier models—another trend of the times.

Calculating Stresses in Hooks and Curved Bars

By C. H. Kent

Head, Department of Mechanical Engineering, University of Arkansas

IN THE calculation of stresses in hooks, links and rings it is not uncommon for the designer to use the expression developed for eccentric loading on a short block, of the form,

$$S = \frac{P}{A} \pm \frac{M_v}{I}$$

in which the symbols have their usual meanings as applied to beams and columns. This formula is used because of its ease of application to regular sections, and in spite of the fact that it may lead to serious error. In order to reduce this error one may apply a correction factor to the result, such as those proposed by Wilson and Quereau[1]. In many sections, however, the determination of v and I demand nearly as much time and effort as would be required in the more exact Winkler method.

No really satisfactory theory of bending applicable to all sections has been discovered up to the present time. Winkler[2] published in 1858 the first important attempt to arrive at such a solution, and Bach[3] afterward elaborated on this method, which remains the most satisfactory one so far proposed. In 1880 Golovin[4] obtained an exact solution for the special case of a thin rectangular section. This solution serves now as a standard with which to compare more general approximate solutions.

It is believed that an expression of sufficient simplicity for practical application may be arrived at by the Winkler method. The cross section m-n of the hook in Fig. 1 is subject to a direct tensile stress due to the load P, and to tension and compression due to the bending action of the load about the neutral axis of the cross section—both of which stresses are included under circumferential stresses. In addition there are radial stresses produced by the action of the longitudinal fibers on one another as they tend to be straightened by the load. These radial stresses the Winkler theory does not take into account at all, but the exact solution shows that the effect of these stresses is small, and the theory is sufficiently accurate for practical application.

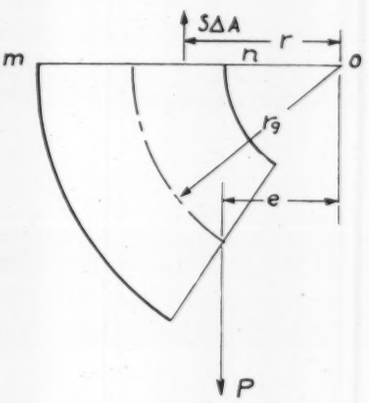


Fig. 2—A portion of the hook shown in Fig. 1, with the force applied at a distance e from the center of curvature

In Fig. 2 is shown a portion of the hook in Fig. 1, with the load applied at the distance e from the center of curvature. If s represents the variable unit stress on the cross section m-n, then the total stress is $\int s\,d\,a$, in equilibrium with the load P and,

$$\Sigma F_y = 0 = P - \int s\,d\,A \quad \text{.....(1)}$$
$$\Sigma M_o = 0 = Pe - \int s\,r\,d\,A \quad \text{.....(2)}$$

In Fig. 3 is shown the cross section m-n and another plane of the hook making the small angle α with m-n before the load P is applied. On the assumption that a cross section of the hook remains a plane as the hook is bent,

[1]University of Illinois Circular No. 16.
[2]Der Civilingenieur (1858).
[3]Elasticitat and Festigkeit.
[4]S. Timoshenko, American Society of Mechanical Engineers' *Transactions*, 1926, p. 667.

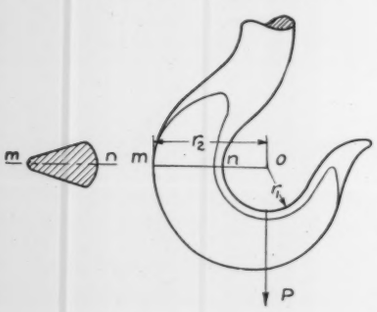


Fig. 1—General view of the hook and forces acting upon it.

which the exact solution shows to be actually the case, the new position of the plane makes the small angle θ with the old. Then if R represents the radius of the neutral axis of the section, which may be considered constant through the small angle α, the unit deformation of any element is given by,

$$\delta = \frac{(R-r)\theta}{r\alpha} \quad \text{.....(3)}$$

(with θ in radians) and since $S=E\delta$, we can write (1) and (2) above as:

$$P = E\frac{\theta}{\alpha}(R\,X - A) \quad \text{.....(4)}$$

$$Pe = E\frac{\theta}{\alpha}(R\,A - r_g\,A) \quad \text{.....(5)}$$

where $X=\int dA/r$, and A is the area of the section m-n. Eliminating $E\theta/\alpha$ between these two equations,

$$R = A\,\frac{r_g - e}{A - eX} \quad \text{.....(6)}$$

and the value of $E(\theta/\alpha)$ is

$$E\frac{\theta}{\alpha} = \frac{P}{A}\left(\frac{A-eX}{r_gX - A}\right) \quad \text{.....(7)}$$

giving for the stress,

$$s = \frac{P}{A}\left(1 - \frac{R}{r}\right)\frac{A - e\,X}{A - r_g\,X} \quad \text{.....(8)}$$

Equation (6) shows that when the line of action of the load passes through the center of curvature, as is common in the case of a hook, the neutral axis of the section coincides with the gravity axis. An analysis of equation (8) will show that the value of the stress s, instead of being directly proportional to the distance from the neutral axis, as in a straight beam, now follows a hyperbolic law. It is necessary that the value of the integral $\int dA/r$ be determined with accuracy. When the section is simple, this may be done easily by calculus, and the values of this integral for simple sections are given in Fig. 4.

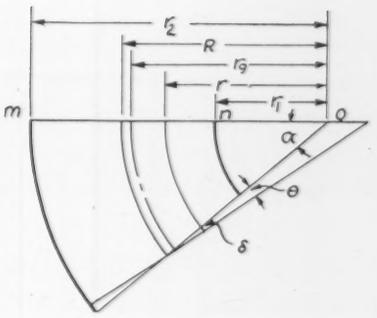


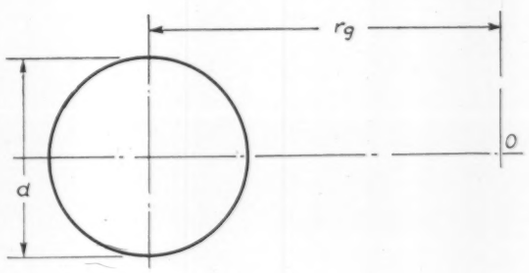
Fig. 3—Representation of the position assumed by a plane of the hook when subjected to stress

When the section is such as to make the application of the methods of calculus impracticable, it is possible to make use of an approximate method of evaluating $\int dA/r$. The application of Simpson's rule, for instance, to the section in Fig. 5, is carried out as follows:

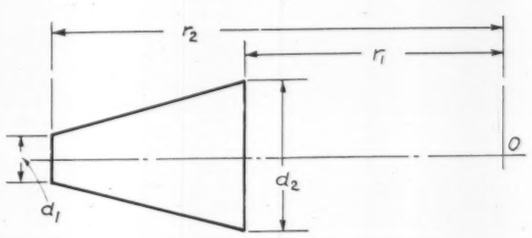
The area is given by:

$$A = \int_{r_1}^{r_2} dA, \text{ where } dA = 2\,y\,d\,r$$

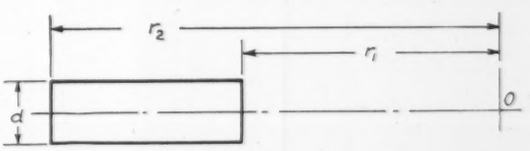
Using Simpson's rule, where d is the dis-



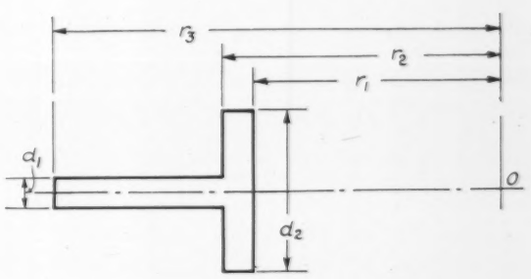
Circle .....$2\pi\left(r_g - \sqrt{r_g^2 - \left(\frac{d}{2}\right)^2}\right)$



Trapezoid $2.3\left(d_1 + \frac{r_2}{r_2 - r_1}\right)(d_2 - d_1)\,\log_{10}\frac{r_2}{r_1} - (d_2 - d_1)$



Rectangle ..... $2.3\,d\,\log_{10}\frac{r_2}{r_1}$



T .....$2.3\left(d_2\log_{10}\frac{r_3}{r_1} + d_1\log_{10}\frac{r_3}{r_2}\right)$

Fig. 4—Values of the integral $\int dA/r$ for simple sections

tance between ordinates and u is the length of the ordinate,

$$A = \frac{2d}{3}\,(u_0+4u_1+2u_2+4u_3+2u_4+\ldots\ldots 4u_{n-1}+u_n)$$

$$A = \frac{2\text{x}0.2}{3}\,(0+4\text{x}0.56+2\text{x}0.69+4\text{x}0.67+\ldots\ldots) = 2.07 \text{ sq. in.}$$

$\int \frac{dA}{r}$, would be $\int_{r_1}^{r_2} \frac{2\,y\,d\,r}{r}$ or $\int_{r_1}^{r_2} \frac{2\,y\,d\,r}{r_1+nd}$

Using Simpson's rule:

$\int \frac{dA}{r}$ is approximately,

$$\frac{2d}{3}\left(\frac{u_0}{r_1}+\frac{4u_1}{r_1+d}+\frac{2u_2}{r_1+2d}+\frac{4u_3}{r_1+3d}+\ldots\ldots\right)$$

$$= \frac{2\text{x}0.2}{3}\left(0+\frac{4\text{x}0.56}{1.25+0.2}+\frac{2\text{x}0.69}{1.25+0.4}+\frac{4\text{x}0.67}{1.25+0.6}+\ldots\ldots\right)$$

$$= 1.01 \text{ in.}$$

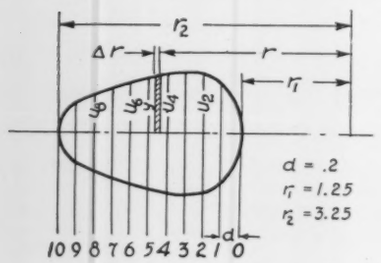


Fig. 5—Hook section which requires the application of Simpson's rule to determine its stress

Actual Values of U

$U_0 = 0$	$U_3 = 0.67$	$U_6 = 0.57$	$U_9 = 0.34$
$U_1 = 0.56$	$U_4 = 0.65$	$U_7 = 0.51$	$U_{10} = 0$
$U_2 = 0.69$	$U_5 = 0.63$	$U_8 = 0.43$	

To find r_g, the distance from O to the center of gravity of this section, note that,

$$A\,r_g = \int_{r_1}^{r_2} r\,d\,A$$

The integral on the right by Simpson's rule would be,

$$\frac{2d}{3}\,(u_0\,r_1+4u_1(r_1+d)+2u_2(r_1+2d)+4u_3(r_1+3d)+\ldots\ldots)$$

$$= \frac{2\text{x}0.2}{3}\,(0+4\text{x}0.56(1.25+0.2)+2\text{x}0.53(1.25+0.4)+4\text{x}0.68(1.25+0.6)+\ldots\ldots) = 4.48$$

Giving r_g=2.165-inch.

As stated above the exact solution for the problem of the curved beam with a thin rectangular section is available for comparison with equation (8). If we assume such a section we find that the exact solution for the maximum stress in the cross section of area A when $r_2/r_1=2$ and when the load P is applied so that its line of action passes through the center of curvature; is 12.88 P/A. Equation (8) gives for this case, 12.63 P/A, an error of less than 2 per cent. Application of equation (1) gives 10 P/A, an error of 22.4 per cent. The error in each of these cases is reduced as the ratio of r_2/r_1 decreases, until at a value of 1.1 for this ratio, the error in using equation (1) is near 3 per cent, and therefore sufficiently accurate for most purposes.

When the ratio of r_2/r_1 has reached the extreme value of 7, the error of equation (8) is 13.3 per cent, while that of equation (1) had increased to 57 per cent. Since in the design of hooks an average value of r_2/r_1 is 2.5, this formula will satisfy all requirements of accuracy for this purpose. It also may be applied to the curved frames of punching and shearing machines, with negligible error.

High Values of Stress Used

It is the practice of designers of hooks to use rather high values for the allowable stress S, when calculated by the method of Winkler, reaching a maximum very near the elastic limit of the material used[5]. More experimental data should be available on tests of hooks to explain the reason for the use of such high working values of stress.

Variations of equation (8) exist in many different forms but it is thought none of them with an equal degree of accuracy can be so simply and easily demonstrated.

[5]C. D. Means, American Society of Mechanical Engineers' *Transactions*, 1926, p. 666.

Alloy Information Listed

COMPLETE data on corrosion and heat-resisting alloys is provided in a booklet prepared recently by the American Society for Testing Materials entitled "Tables of Chemical Compositions, Physical and Mechanical Properties and Corrosion-Resistant Properties of Corrosion-Resistant and Heat-Resistant Alloys."

The data is in two parts, compositions and physical and mechanical properties, and corrosion-resistant properties. Alloys are listed alphabetically by companies and by trade names under these companies.

Another recent publication of the society is "A List of Alloys," prepared by William Campbell for committee B-2 on nonferrous metals and alloys. This list, as revised and amplified in 1930, gives the physical properties of 1650 typical alloys, as well as their chemical composition. Alloys are listed by trade names under headings such as brasses, bronzes, copper-nickel alloys, etc. Company names are not given.

Both booklets may be obtained from the American Society for Testing Materials, 1315 Spruce street, Philadelphia, for $1.50 each.

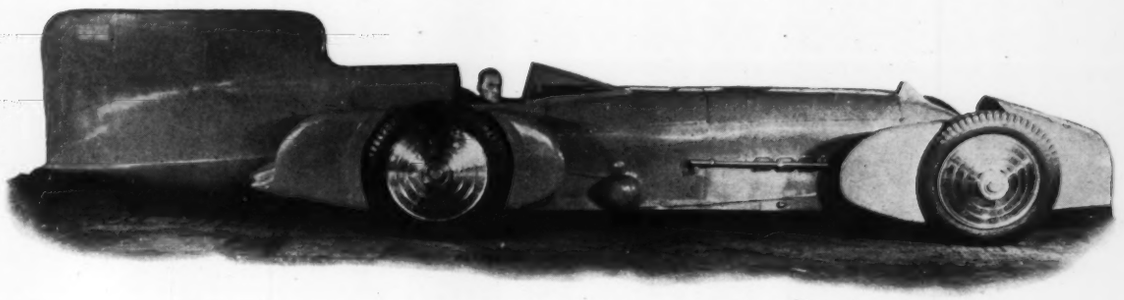


Fig. 1—Sir Malcolm Campbell at wheel of Blue Bird before tests were held

Record Breaking Bluebird Embodies Unique Design Features

By A. M. Wolf

Automotive Consulting Engineer, New York

SPEED, so symbolistic of our modern age, always fascinates the mind. A speed of 245.736 miles an hour for a land vehicle stimulates the imagination. However, it is an accomplished fact, for on Feb. 5 Sir Malcolm Campbell broke the previous world record of 231.369 miles per hour held by the late Sir Henry Segrave. The automobile world can well be proud when it is considered that the airplane speed record is but little faster, namely 278.480 miles per hour. The fastest speed accomplished by man is held by a seaplane at 357.723 miles per hour. For a long while the seaplane was considered necessarily slower due to the resistance in the air of the floats or pontoons. Unless the airplane, with its inherent lower resistance possibilities, improves its present record, it soon will be eclipsed by a land vehicle.

Aviation Engine Is Employed

The Blue Bird is powered by a twelve cylinder Napier aviation engine, of 5½-inch bore and 5⅛-inch stroke. It is of the W type in which one bank of cylinders is mounted vertically on the crankcase and another bank radially disposed at each side at an angle of 60 degrees with the vertical. It is virtually three four-cylinder engines with a common crankshaft and case. A master connecting rod couples the vertical piston with its crank pin in the usual way. A lug is forged at each side of the big end and the connecting rod of each side cylinder is pin-jointed to the lug on its side. While the side pistons have a motion slightly different than the vertical one, the error is small and is warranted by the simplicity of construction. The majority of aviation engines, including the radial, utilize this type of master and auxiliary rod construction.

Other typical aviation engine features are

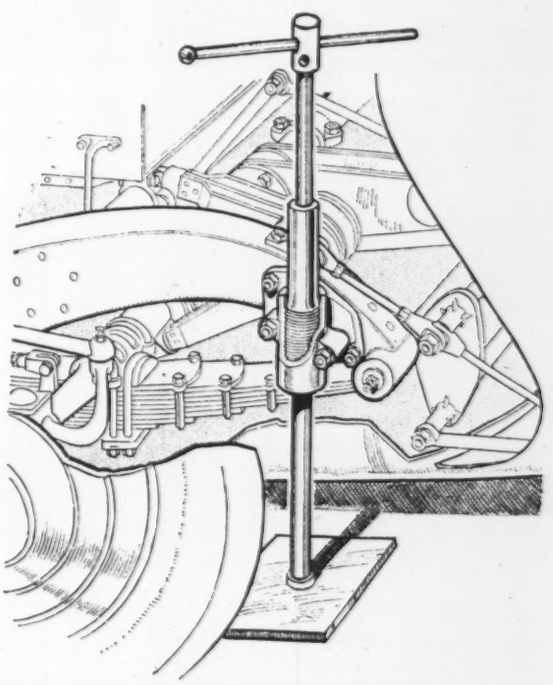
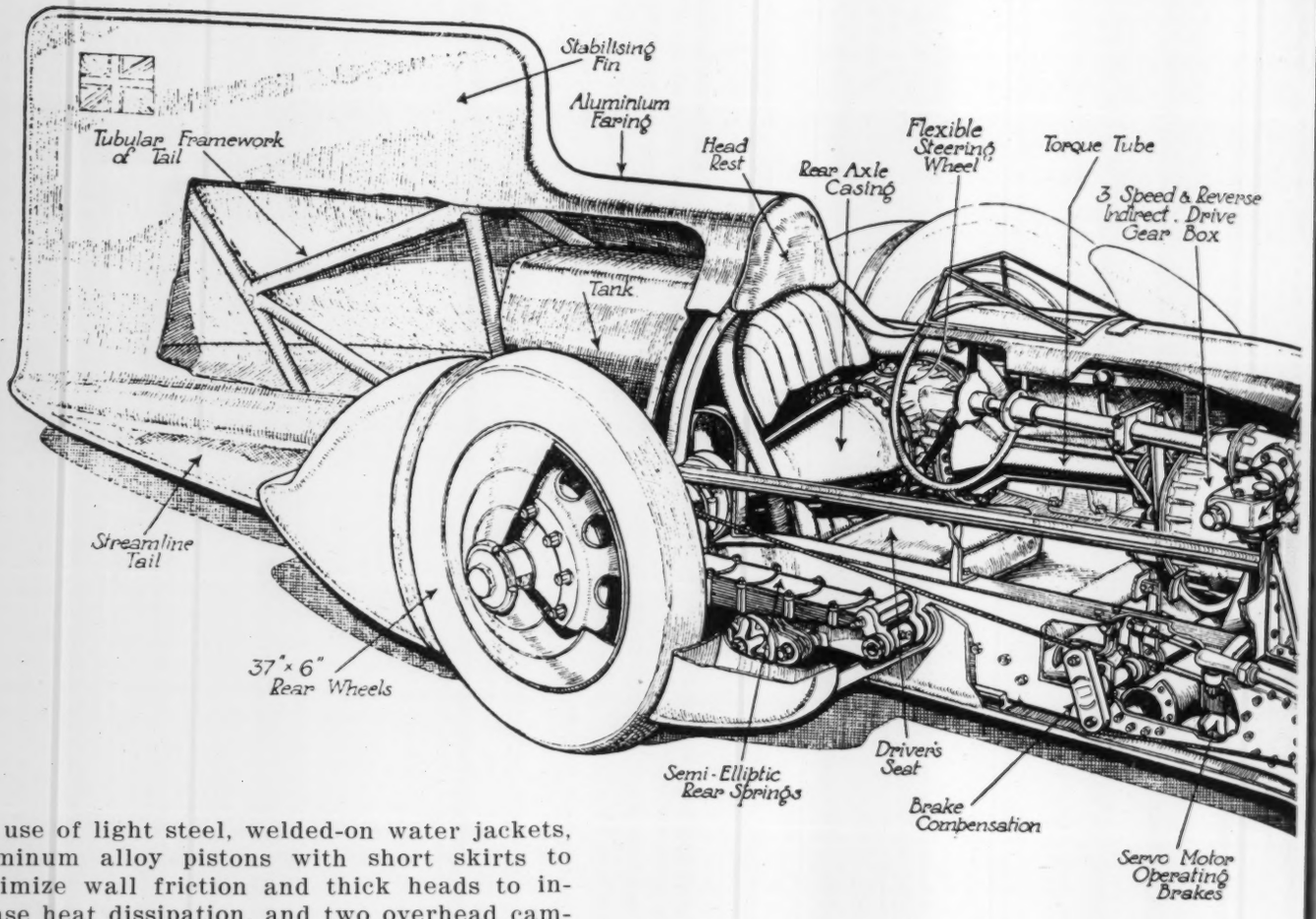


Fig. 2—Simple jacking system is used



the use of light steel, welded-on water jackets, aluminum alloy pistons with short skirts to minimize wall friction and thick heads to increase heat dissipation, and two overhead camshafts—one for the inlet and one for the exhaust valves—mounted in a housing on top of each cylinder bank and driven from the crankshaft by a single shaft paralleling the cylinder axis. A supercharger is used, having three carburetors and air-intakes. The engine develops 1450 horsepower at 3600 revolutions per minute which, with a displacement of 1461 cubic inches, gives an output of practically 1 horsepower for each cubic inch. The car weighs 7840 pounds. There is therefore 1 horsepower for each 5.4 pounds of car weight. This performance figure will be appreciated when it is considered that our "snappiest" automobiles have from 24 to 34 pounds of car weight per horsepower. The weight given of the Blue Bird includes large lead weights mounted inside the frame channels at the rear to insure traction.

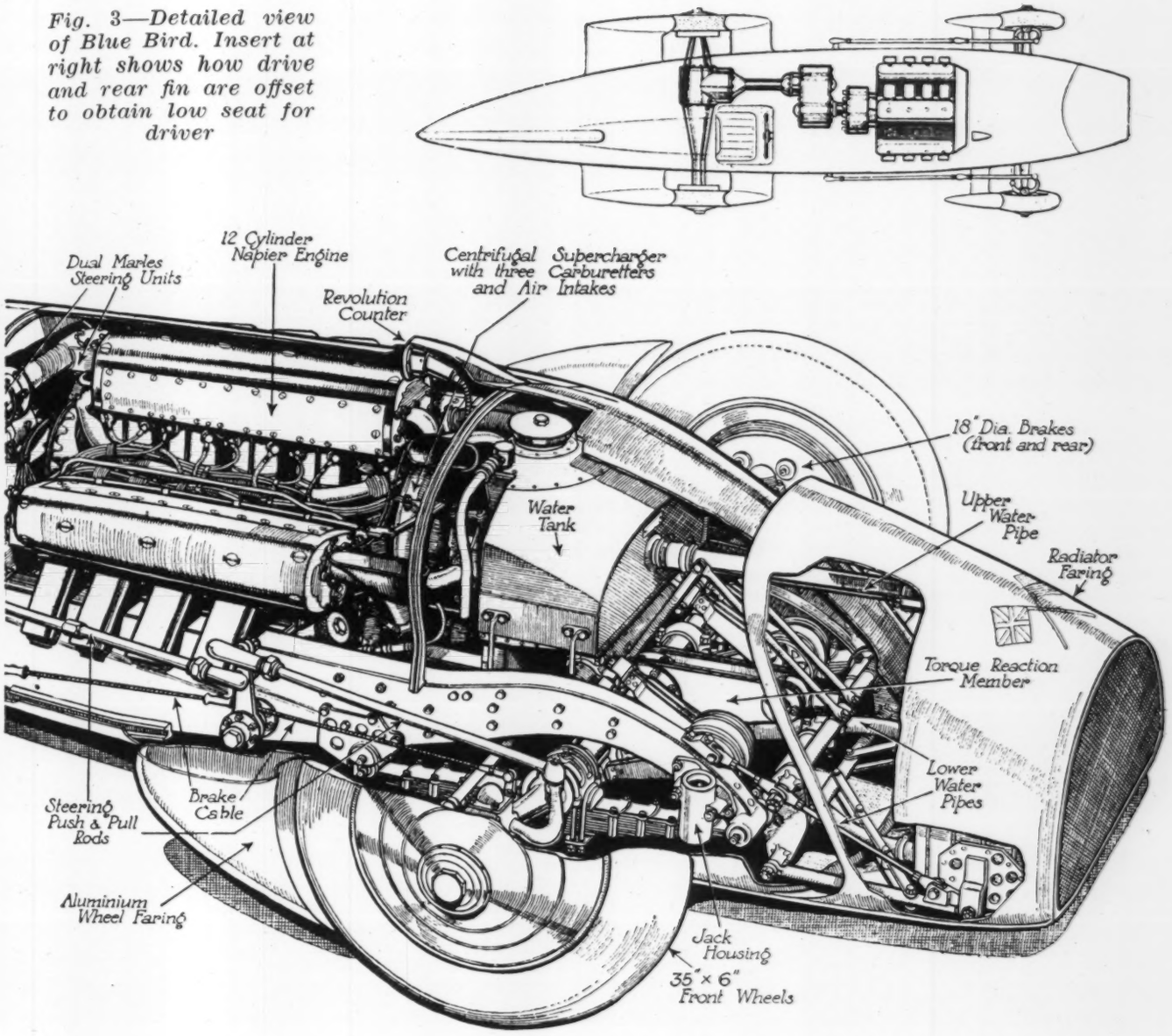
Three Point Engine Mounting Used

The chassis frame consists of two deep side rails tapering at each end, held together by tubular cross members some of which are machined from solid forgings. An underpan along the center portion of the frame also ties it together for maximum rigidity. The engine has a three-point mounting on a sub-frame, with one support at the front and two at the rear, all of which are spherical to eliminate any possible binding should there be any frame weave. The frame passes under the rear axle and over the front.

The wheelbase is 147 inches and the overall length 25 feet. The tracks of the front and rear wheels are 64 and 62 inches respectively. Overall width is 6 feet. When the car is standing still, the minimum ground clearance is 5 inches. At speeds over 150 miles per hour, it increases to 6½-inch due to the deformation of the tires. The reader will conceive the enormity of the centrifugal forces at work and realize why the tires have only a 1/32-inch thickness of tread. Otherwise it would be thrown off. The three-inch increase in tire diameter automatically "gears-up" the vehicle. That this actually occurs has been confirmed in tests made by the Duesenberg company who found that at 50 and 100 miles per hour, the engine turns over 2070 and 4090 revolutions per minute respectively. That is 50 revolutions less than twice as fast, in spite of the necessarily greater tire slippage at high speed.

The Blue Bird is cooled by a radiator set out in the air stream. The cooling problem is a difficult one with such high speed vehicles in view of the air resistance encountered. It will be recalled that last year's Silver Bullet described in the May issue of MACHINE DESIGN had an engine circulating system cooled by an ice-tank in the nose of the machine. This was done to eliminate any resistance that an outside

Fig. 3—Detailed view of Blue Bird. Insert at right shows how drive and rear fin are offset to obtain low seat for driver



heat dissipating means might cause. However it added considerable weight. As a compromise, Campbell was willing to sacrifice a little on the score of air resistance rather than increased weight. His arrangement of the radiator caused a furore of criticism in England but the performance of the car has vindicated his judgment. The cellular radiator, 20 inches high and 30 inches wide, is carried on a forward extension of the chassis frame and is outside of the streamline body. In this way air passing through the radiator does not enter the body as in the ordinary car. Otherwise the inside of the body would "pile-up" with air which would interfere with the driver as it emerges from the cock-pit and also increase the air resistance. The fairing extending back from the radiator leaves a gap between itself and the nose of the body, which is of true streamline form, for the escape of the air passing through the radiator. This air passing back over the body tends to lift the surrounding air impinging on the body and thereby reduce the skin friction. Its action is similar to that of the cowling ring for airplanes developed by the National Advisory Committee on Aeronautics in this country, and Townsend in England.

Single Water Pipe Is Used

The top of the radiator communicates with a large water tank in the nose of the body through a single water pipe. Two return pipes from the radiator feed cool water to a large centrifugal pump on the engine. The water tank is provided with a filler cap, being at the highest point in the cooling circuit. The radiator core is "submerged." Beside the filler is located a valve that normally is closed, opening only if steam should develop. Its purpose is to prevent the surge of water down the overflow pipe which would occur during rapid ac-

celeration. Such a condition is not encountered in the ordinary automobile and indicates the special expedients that must be resorted to in this ultra high speed work.

The fuel tank, holding 23 Imperial gallons, is mounted immediately behind the driver. A mechanical fuel pump feeds the carburetors. As the fuel in the line from the tank to the pump also is subject to violent acceleration, it might not flow under gravity head to the pump but rather in the opposite direction. To counterbalance this condition, an air pressure system is used through the use of a hand-operated pump. The engine is started by a method used frequently in Europe in air service. A small hand pump conveys fuel to a nozzle of a miniature carburetor which is connected to piping running to each cylinder. The engine is primed first, air is passed through the nozzle coming from a compressed air bottle, and then a spark from a hand magneto occurs in the cylinder

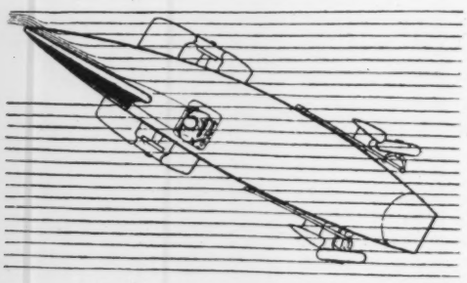


Fig. 4—Rear fin assists in rectifying deviation from straight

ready to fire. A hole in the nose of the body supplies air for the carburetors. Its high location precludes the possibility of the entrance of beach sand. One of the air intakes is very low, being as close to the undershield as possible without causing any restriction. In fact it was this intake that determined the ground clearance and height of the car.

Disk Clutch Carries the Drive

The crankshaft is fitted with a flywheel where ordinarily the propeller is mounted. A disk clutch carries the drive to the transmission. Because of the necessarily high spring pressure required, a reducing leverage is interposed between the pedal and the throw-out bearing. The transmission has three speeds forward and one reverse, all being indirect drive. The main shaft is of course in line with the engine and the driven shaft offset to the left. This was done to avoid a centrally located propeller shaft which would necessitate a high position of the driver over it. It will be recalled that the Silver Bullet had a drive shaft at each side, one to each wheel, with the driver located between the two shafts. Sir Malcolm Campbell offset the rear axle bevel pinion 7 inches from the center, toward the left. In this way the driver has sufficient room between the single propeller shaft and the right side rail. It was possible to place the bottom of the seat 10 inches from the ground and the top of the glass windshield 45 inches therefrom. A single universal joint is used, enclosed within the ball end of the torque tube. Steel sleeves extend to each wheel from the offset gear housing and the wheels are mounted in full floating construction. Disk type wheels are used, mounted by ten cap nuts each and faired off by a cover.

Springs Swivel on Axle

The front axle is oval in section and has a centrally located radius rod which acts as a torque reaction member when braking. It also holds the steering knuckles at a predetermined angle, thereby assuring proper caster action. The front semi-elliptic springs swivel on the axle in order that their action may be free from any restraint that otherwise would be imposed by the radius rod. The spring is fixed at the front and shackled at the rear. Two friction-type shock absorbers are used for the front axle at each side, being forward of the axle, and within the frame side rails. At the rear, one shock absorber is used in front and the other to the rear of the axle at each side. Semi-elliptic springs also are used at the rear, swivel mounted on the axle tubes and shackled at each end.

Braking is a considerable problem with these vehicles. Most people appreciate the need of power to accelerate and maintain high speed but overlook the fact that the car also must be stopped. The course at Daytona Beach is nine miles long, giving four miles to accelerate in, one mile for the measured course and four miles to slow down in. That the Blue Bird had efficient brakes was proved one day after practice when spectators drifted on the course and Campbell was required to make an emergency stop to avoid running them down. He made a remarkable stop at the expense of burning out his brake linings which, however, were quickly replaced. Brake linings consist chiefly of asbestos which of course is a non-conductor but the immense amount of heat developed warrants every effort to keep the heat from the brake shoes and to throw it into the drum where it can be dissipated. A lining was used which was developed and has been used for some time in England with this purpose in view. The braking surface is continuous but the inner surface which contacts with the shoes is serrated or interrupted, providing an air space insulation therebetween. The foot pedal pressure is augmented by a vacuum booster which actuates the single cross shaft.

The steering gear has a horizontal column extending back to the driver and mounts a

(*Concluded on Page* 64)

Defects in Design and Tooling of Bearings

By C. H. Bierbaum

Fig. 1—Copper-rich crystals form at "a" during solidification

BEARINGS always have been a matter of pertinent interest to the mechanical engineer, especially so in relation to machine design, where they often are prompted by pure necessity rather than choice. The subject of bearing alloys and their metallurgy has been given intensive study during recent years, with the result that distinct progress has been made. Yet however perfect the steel in the journal and the bearing alloys for the bearings may have become, they cannot give a maximum of satisfactory service when obvious errors in their design and tooling still exist.

A shortcoming in machine design that merits special attention and criticism at this time is the practice of recessing the outside surface of bearings and bushings. It is well known that all cast metals have a skin or chill upon their outer surfaces and that these surfaces are more or less under stress. In practically all cases we find that the surfaces are appreciably harder than the inner part of the casting, showing that a distinct lack of homogeneity exists throughout a cross section of a casting. This is true especially in alloys of distinctly crystalline formations, such as bearing alloys of necessity always must be.

It now is generally accepted as a metallurgical fact that all bearing alloys are composed of relatively hard and soft crystals, but these crystals have additional characteristic differences aside from that of their physical or microhardness; namely, the difference of melting temperature and the difference in change of volume while cooling from the fluid to the solid state.

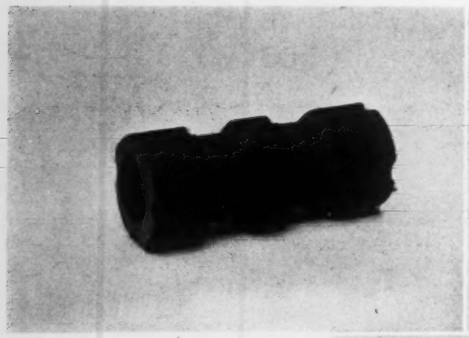
SOME of the pitfalls in the design of plain bearings are discussed in the accompanying article, Mr. Bierbaum deploring particularly the practice of providing recesses on the outer surfaces of bearing castings. The author is vice-president, Lumen Bearing Co., Buffalo, and from many years experience in this field is particularly well qualified to treat the subject of bearing design and application.

Atoms Separate During Cooling Process

With the foregoing facts in mind, let us consider what is going on when a copper-tin bronze solidifies. The cooling of the molten bronze progresses to a point where the first crystal begins to form at "*a*" in Fig. 1. This is a copper rich crystal. Owing to the fact that copper has the higher melting point, it tends to solidify first. Other reasons for this tendency are that the volume of the tin atom is more than twice that of the copper, and that these two metals differ in their natural orientation of atomic structure; the copper atoms tending to orient themselves in the face-centered cubic lattice structure and the tin atoms tending to orient themselves in the body-centered tetragonal lattice. They have, therefore, a distinct tendency to separate during solidification. The slower the solidification proceeds the more complete this separation becomes, and the less the amount of tin remaining in solid solution in the first crystal formed.

This first crystal is known as the alpha crystal, and, owing to its high copper content, always must be

the softest. It first begins to grow as a spike-like formation upon and at right angles to the cooling surface; the primary formation, as it continues to grow, throws off secondary spikes at regular intervals at right angles to itself. This complete formation of the alpha crystal is known as the dendritic or "pine tree" formation. The length of the primary spike depends upon the rate of cooling and also, to some extent, upon the proportionate composition of the alloy; other things being equal, the slower the cooling the longer will be the primary formation.



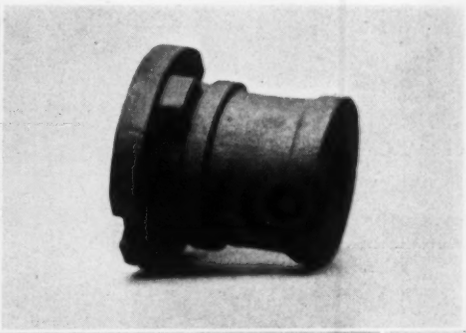
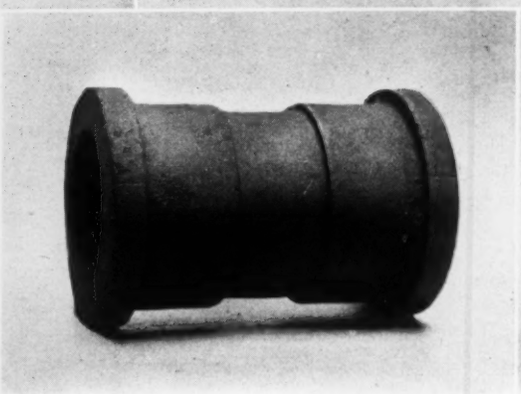


Fig. 4—(Below, Left)—Solid casting for split bushing. A sleeve of uniform thickness would have contributed better design. Fig. 5—(Below) Lubrication spaces are incorrectly provided on outside diameter of casting

Fig 2—(Above)—Provision of interrupted supporting ridges on outside diameter is undesirable. Fig. 3—(Above, Right)—Wall thickness of this bearing is greater than economy and good service demand. Extreme variations in wall present difficulties



In ordinary foundry practice, with its corresponding chilling effect, this primary surface dendritic formation extends into the casting varying distances up to, say ¼ to ⅜-inch. If in such cases the thickness of the casting is ¾-inch or less the dendritic formation, starting on both surfaces, may extend through the entire cooling mass and tend to form a complete interlocking structure, a condition which always makes a sound casting. On the other hand. these primary surface dendrites do not grow to an indefinite length; therefore in heavy castings, with their consequent slower cooling, a large number of independent dendritic formations appear, giving rise to the different grains as they appear on the surface of a metallographic specimen made from such a section.

There is an interval in the cooling or the solidified state of a copper-tin bronze, when at any one point the molten mass becomes permeated throughout with these dendrites or solidified alpha structure. At the same time there remains a considerable amount of the material still in a fully molten state disseminated throughout this dendritic formation. Upon further cooling, the remaining molten material undergoes a change of volume due to solidification, but the volumetric contraction of the latter, in changing from the liquid to the solid state, is greater than the corresponding contraction of the already solidified alpha structure, under a further decrease of temperature. The results are that the interstices between the alpha crystal formations are not compactly filled. This gives rise to microscopic cavities and in many cases these cavities aggregate and become large enough to be distinctly macroscopic. Thus an annoyance occurs that is especially prevalent when the castings have irregular outside surfaces with sharp internal and external corners and edges, and more particularly so when this is aggravated by extreme variations in wall thicknesses which cause uneven solidfying, feeding and shrinking.

Basis for Criticism Often Incorrect

These conditions frequently lead to criticisms, expressed as "sand-holes," "blow-holes," "oxide spots," "porosity," "sponginess," and the like, when in fact there is nothing present to detract from the bearing values of the castings, except possibly their appearance under close inspection. In this connection it always should be borne in mind that the bronze compositions having the highest merits as bearing alloys are the most prone to this class of criticism under the foregoing conditions and faulty design.

The coefficient of thermal expansion of all

bearing alloys is greater than that of both cast iron and steel, the usual housings for bearings. Therefore a bronze bearing which has been driven tightly into a housing must expand inwardly when the same is heating up in service, since the bushing always is at a higher temperature than the housing. Where a bushing is supported in the housing by lugs or supporting rings, it is evident that the unsupported part of the bushing tends to expand outwardly, whereas the parts of the bushing corresponding to the surfaces supported on the outside must expand inwardly and thus in turn present an uneven bearing surface to the journal; although the fitting of the bearing may have been done in a most accurate and workmanlike manner. The design is clearly at fault.

Wall Thickness Affects Expansion

It also is common practice in the design of bushings and sleeves, which have outside recessed surfaces, to make their aggregate thickness greater than those not so recessed. This is a self-evident evil in that the greater the thickness of bearing material between the journal and the housing, the greater must be the resulting inward expansion. Therefore an excess thickness of bushing should be avoided.

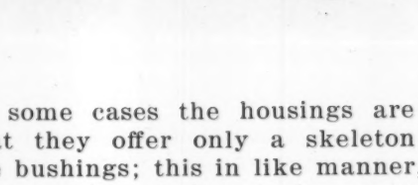


Fig. 6—(Center)—Incorrectly designed tapered sleeve bearing. Fig. 7—(Below) — Supporting lugs on outside of one-half of same bearing

In some cases the housings are so designed that they offer only a skeleton support for the bushings; this in like manner, for the reasons mentioned, is open to severe criticism in that it subjects such a bearing to the foregoing shortcomings.

The recessing of the outer surface of bearings and bushings has another undesirable effect in that the harder outer skin is removed on the tooled areas only, leaving the untooled areas with the surface skin under stress. This, in consequence, has the tendency of warping or distorting the bushing after tooling. To a certain extent, this tendency for distortion can be reduced materially, if not completely overcome, by annealing or conditioning the bearing either before tooling or after rough tooling. Such annealing, however, should be done only under competent metallurgical supervision, for the simple reason that if bushings in the annealing process are heated above a definite temperature a crystalline reabsorption occurs; that is, the hardest bearing crystal is destroyed, which reduces the bearing value of the bronze materially. All in all, it is cheaper in order to avoid these many vexing problems simply to discontinue the practice of recessing bearings and bushings on their outside surfaces.

Fig 2 shows a solid bushing with three interrupted supporting ridges on its outside. The design contemplated using the interrupting spaces in the supporting rings for ventilation for the cooling of the bushing. This is an obvious error, since a straight cylindrical bushing making contact with its housing throughout its entire outside surface would have a far greater heat conducting capacity than the design shown.

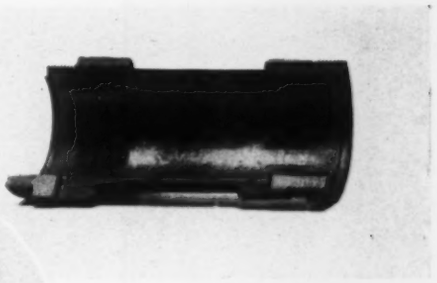


Fig. 8—(Above)—Appearance of inside of half bearing after service. Note that surface of journal was in contact only on spots corresponding to outer supporting lugs

If the same amount of metal had been used in designing a plain cylindrical bushing of uniform cross section a superior construction would have resulted.

A solid bushing recessed on its outside for lubrication space is shown in Fig. 3. The aggregate thickness is altogether in excess of what economy and good service would require. The lubrication space on the outside serving in part as a heat insulator and the extreme thickness of bushing increases the aggregate inward expansion should warming or heating occur. As a foundry product it presents all the disadvantages of a casting having extreme variations of thickness of wall, also having sharp internal angles tending to prevent proper feeding, making such a casting liable to shrinkage and porosity.

Fig. 4 is a solid casting intended to be finished

as a two-part split bushing to be used with a cap and shims. This design also would have been improved had the same amount of metal been used for a sleeve of uniform thickness with a flange on each end. In Fig. 5 is a solid bearing recessed for lubrication space. A superior construction would have resulted had this heavy bushing been made with the same amount of material or even with less metal and then put in the form of a bushing with a flange on one end. In addition, this design is subject to the same criticism as that of Fig. 3. In this casting all of the outer skin cannot be removed.

The bushing shown in Fig. 6 may be considered as the *reductio ad absurdum*. It was not intended as a humorous expression in machine design, quite the contrary. It was put in service by a machine tool manufacturer of international reputation. It is the tapered sleeve construction with a complete slit on one side. In Fig. 6, an original casting is shown. After cutting the same in halves, the outside of one half is illustrated in Fig. 7. Fig. 8 shows the inside of a half bearing after it had been taken out of service. In the latter figure it clearly is shown that the journal bore only upon the surfaces corresponding to the supporting lugs on the outside, and why such an unsatisfactory service resulted.

In general, it may be said that the rubbing surfaces of a journal and bearing should be such that they mutually will polish each other in order to overcome inaccuracies and limitations in the mechanical finishing of these surfaces, thus making the "running-in" or initial wearing down process a necessity for all bearings. Now, it will be conceded readily that the amount of this necessary initial wearing down is reduced as the mechanical accuracy of such surfaces is increased.

Accuracy Is An Economical Achievement

These conclusions bring up the question: Can the degree of perfection of tooling be brought to such a state that no "running-in" is necessary? The answer is that close approaches have been reached and manufacturers have found that the highest possible degree of accuracy is an economical achievement. The steel journals in general can be finished by grinding and in doing this work it should be borne in mind that accuracy often is of far more importance than the most highly burnished surfaces.

Bearing alloys being composed of hard and soft crystals, their surfaces can be finished best by tooling with a sharp diamond cutter, taking a depth of final cut of .001-inch or less at a high-speed. The effect thus produced is that of not having disturbed the crystals upon the bearing surfaces*, and the hard bearing crystals will be flush with the finished surfaces. In this manner, surfaces can be produced that require a minimum of running in.

*The American Society of Mechanical Engineers' *Transactions*. Dec., 1919, pp. 799-802.

Incorporating Standard Units in Machines

By George T. Chapman

INCORPORATION of standard units in the design of labor saving machinery often not only lowers the initial cost, but at the same time produces a more efficient machine. In the design of this special equipment, the initial cost may prohibit construction, and although it is not always justifiable and possible to incorporate standard units these often aid in reducing the expense.

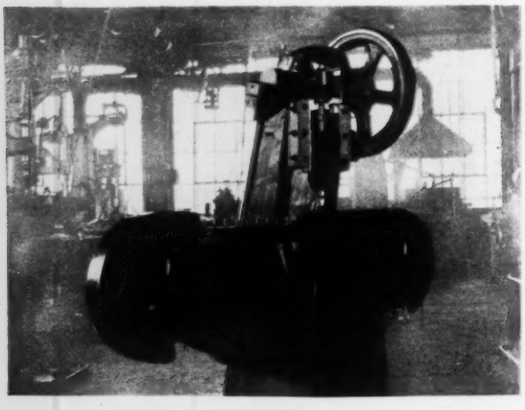


Fig. 1—View of completed machine

In redesigning a machine for a forming operation on a small metal tube which did not lend itself to magazine feeding, the problem was to at least triple the production per operator with equipment costing not over $2500. Existing production was 1000 per hour. The appropriation provided did not afford much margin in which to construct entirely new devices, as will be appreciated by those familiar with design of special machinery.

A standard punch press was used, Fig. 1, this being mounted on a base designed to support the geneva wheel, described in the March, 1930, issue of MACHINE DESIGN, as well as the brackets on each side of the machine which carry the sprockets and bearings. The bearings on the left are adjustable and act as a take-up for the

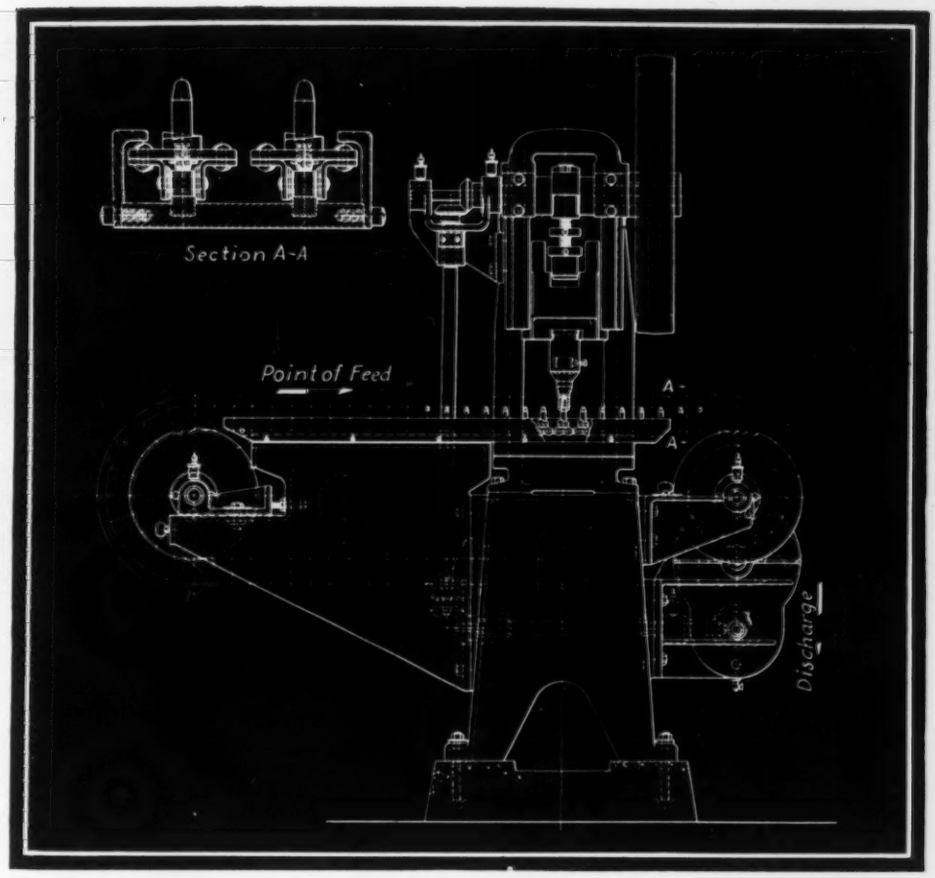


Fig. 2—A standard punch press is used in the design of this machine which performs forming operations on small metal tubes. Special safety guards so protect the operator that there is little likelihood of serious accidents occurring

roller chains on which the forming dies are mounted.

Section *A-A*, Fig. 2, shows a section through the chains, guides and dies. The rollers of the chains ride on hardened and ground steel bars mounted in a steel plate and extending the full length of the bracket on the left and over the bed of the press. These plates not only act as a tie between the brackets and the bed of the press, but also serve as a means of lining up the bars on which the chains ride. The bars are made up in sections ten inches long to facilitate heat treating. Intermittent motion is transmitted to the chains by means of the geneva wheel, and the travel, which equals the center distance of the pins on the chain, is obtained by means of the gear reduction shown.

Parts Discharged by Gravity

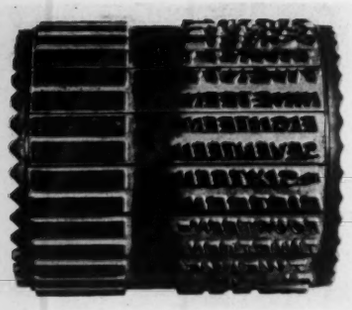
The machine was designed for two operators who are positioned at the left, one on each side of the chain conveyor. The parts to be formed are placed over the guide pins which in turn move to the right and pass under the double plunger where they are formed. From here they pass to the right and discharge by gravity into a receptacle or on to a belt conveyor.

In the design of the machine, considerable thought was given to methods of guarding the operators from injury. The shaft which connects with the crankshaft of the press by means of the bevel gears, and which forms the main drive for the geneva wheel, is enclosed in steel tubing which remains stationary and acts as a guard, preventing the clothing of the operator from becoming entangled. A guard also is provided over the pins, extending about eight inches to the left of the plunger. This is beveled at the extreme left end so that in case the operator allows his hand to remain on the conveyor, it will be removed by the guard before it reaches the plunger. Since the plunger on its upward stroke does not rise above the guard, it is impossible for the operator's hand to be injured. Guards also are provided, as shown by dot and dash lines, over the sprockets at each end as well as over all gears. Two guard rails, shown in both section *A-A* and elevation of the machine, act as a hand rest and guard for the operator as well as a guide for the chain.

With two operators, the production of the machine was 7200 per hour. The total cost, including standard press, patterns, castings, material, labor and overhead was $2000.

Extruded shapes used for pin tumbler lock cases have been found to effect a saving over milled parts or castings of $9 per thousand pieces at the plant of Independent Lock Co., Fitchburg, Mass., according to a recent Nielsen survey. Many of the pieces produced were typical extrusion jobs, and the savings were made by the elimination of finishing operations.

Die Castings Reduce



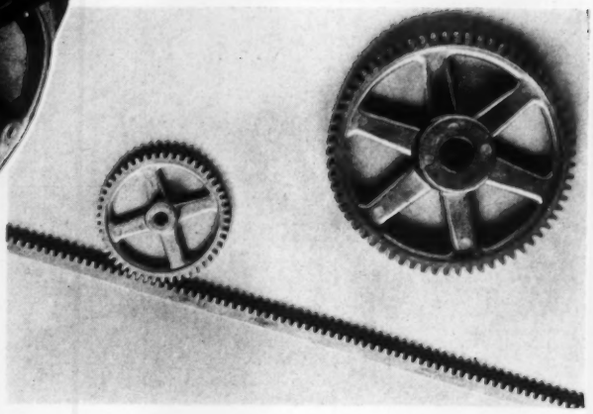


Fig. 1 — (Above) — Check protector incorporating cast type. Fig. 2—(Center)—Die cast gear housing. Fig. 3—(Right) — Zinc alloy gears, die cast, have numerous advantages

MANY production problems are being solved by die casting and interesting new applications constantly are being brought to light. The very nature of "pressure" castings holds promise of greater development in the future, as new alloys are perfected and the design of dies becomes even more complex. "Pressure" casting, employing the application of external pressure, either air or mechanical, or a combination of both, is best suited for the rapid production of strong, sound castings. The perfection of zinc base alloys suitable for the die casting method and capable of withstanding the service for which they are required has been one of the greatest factors in the development of this production method.

Possesses High Tensile Strength

A popular zinc die casting alloy is known as the "4-3-.1" (or "4-3-.05") alloy. Made with high purity zinc, this material gives high performance in service; there have been no complaints when the uncontaminated alloy was properly employed. With a tensile of 46,000 to 48,000 pounds per square inch, an initial impact strength of over 125 foot pounds per square inch, freedom from growth through intercrystalline oxidation, and a decided retardation of internal phase changes, this alloy shows a vast improvement over the old 6 per cent tin alloy and has important advantages over the 4 per cent aluminum—3 per cent copper alloy. Table I shows the analysis and properties of the alloy.

Although not confined to the automotive industry, it in particular had adopted the 4 per cent aluminum—3 per cent copper alloy for places where it was feasible before the 4-3-.1 was introduced. With the new alloy there has been a remarkable increase in the number of users, and the kinds of industries using it.

The accuracy and detail which are primary requirements in the majority of machine parts are typified in the die cast check protector shown in Fig. 1. Die casting with zinc alloys gives the extremely sharp detail necessary. Increased hardness of the new alioys assures a face with such better wearing qualities that taxi meters, calculating machines, and other products of the same general nature now incorporate zinc base parts produced by the die casting method.

One of the advantages a die casting has over the same part cast in sand is its greater accuracy. The large, complicated gear housing casting illustrated in Fig. 2 is an example. Closer tolerances can be maintained, thinner walls cast and smaller holes cored than when former methods were employed. Zinc die castings are sturdy enough to withstand vibrations, and where the die cast metal itself is used as a bearing surface there is a distinct saving.

While die cast gears made of zinc alloys, Fig. 3, have certain obvious limitations, they

Machining

By C. R. Maxon

INCREASINGLY popular employment of alloy die castings for machine parts renders the data contained in this contribution of pertinent interest to the design field. The author is engineer, The New Jersey Zinc Co., New York. He presents useful and timely information on the application of die castings incorporating inserts for providing increased strength, special electrical properties, friction qualities, etc., at localized points.

have interesting possibilities. Where proper lubricants are selected and excessive loads are not encountered, and their use merits consideration. In cases where unusual stresses occur it often is found possible to use steel inserts.

Fig. 4—(Above) — Carburetor assembly built almost entirely from die cast parts

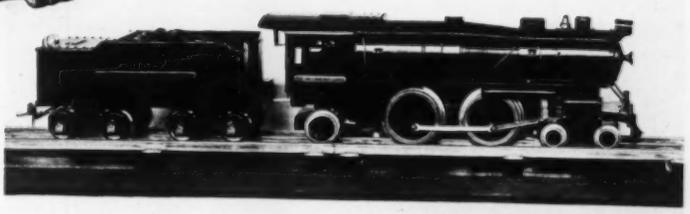
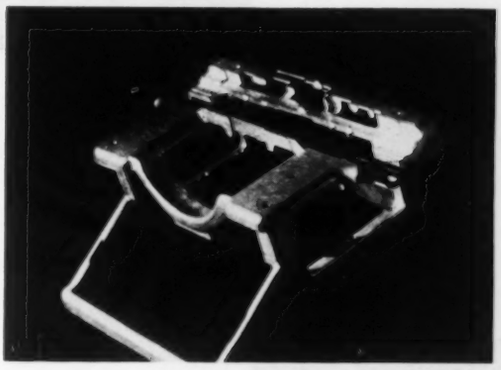


Fig. 5—(Left)—Accuracy of detail is retained by die casting the shells of toy locomotives. Fig. 6—(Below) — Typewriter frame die cast from zinc alloy



At the present time assemblies for regulating seats, windows and windshields are employed successfully in the automotive field. Die cast gears also are used in connection with roadside gasoline pumps and washing machines. Gears of various sizes are available commercially.

Reasons why carburetors are die cast from zinc alloys are apparent. Fig. 4 shows an assembly of small, complicated castings with brass at certain points where good engineering design dictates its advisability. A saving in machining costs ensues, the dies being so designed that the removal of "fins" by a small file in the hands of unskilled labor is the only finishing to be done.

Employment of inserts often has made the die casting process applicable to parts formerly confined to more complicated production methods. Inserts of steel, brass, bronze, porcelain, etc., may be used. They are cast in place, solidification of the zinc alloy "shrinking" on to the insert sufficiently to anchor it. A variety of advantages are:

Greater strength for points of stress

Increased hardness at certain positions

Electrical properties at localized points

A means of lubrication to inaccessible points

Better friction qualities at localized points

Soldering or brazing on castings made from alloys (such as aluminum alloys) which ordinarily cannot undergo these treatments

Reduced assembly and handling costs.

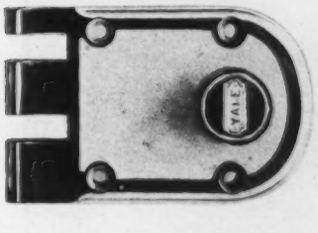


Fig. 7—(Right) — Plating can be applied readily to the buffed surfaces of the castings

Frequently the use of inserts, cast in place, eliminates three or four assembling operations and provides a better, more simplified part.

The die cast rotor pictured in Fig. 8 shows steel laminations cast as an integral part. In the electrical field zinc die castings are serving in many capacities, among the applications being those to kitchen mixing devices, radio parts, electric fan parts, motor housings, end brackets for small motors, brush holders and switch board parts.

Detail, in toys, is a primary requirement. The shell of the toy locomotive, Fig. 5, is a single die casting, and is an exact replica of an Atlantic type locomotive. Of importance also, and greatly affecting the salability of count-

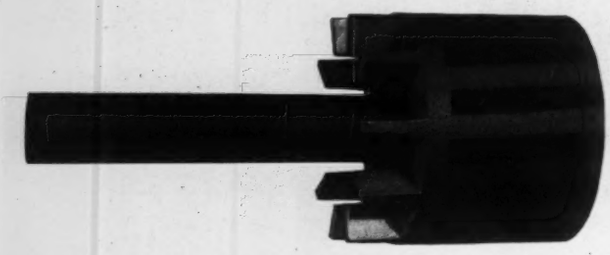


Fig. 8—Rotor in which steel inserts are incorporated as integral parts

less products, is the finish. Consequently it might be well to disgress a moment from a discussion of tolerance, accuracy, detail and other properties to refer to finishes.

Much work has been done in the past few years relative to finishing properties, and the results have been more than gratifying. Almost any type of finish may be applied, whether it be electroplated coating of nickel, chromium, copper, brass, cadmium, silver or gold, or enamels and lacquers. With the smooth surface obtained on zinc die castings little work is necessary in preparation of the casting for plating, a slight buffing and polishing operation being the only requirement before applying the finish. The radio loud speaker shown in Fig. 9 is not walnut, but a zinc die casting.

The frame of a typewriter, Fig. 6, cast in two pieces, is one of the most interesting examples of the application of die castings. It is higher in strength than the type of castings it supplanted, but its particular interest, from the standpoint of one considering the applicability of die castings, is the holding of the close tolerance required. Earlier methods of manufacture involved an extremely large number of machining operations, particularly on the upper part of the frame. By die casting the frame, practically all machining has been eliminated.

Strength has been mentioned incidentally in

TABLE I

Properties of Die Cast Zamak No. 2

Composition	4% aluminum 3% Copper .05% to 0.1% Magnesium Balance High Purity Zinc
Specific gravity	6.8
Melting point	393°C. (741°F.)
Shrinkage allowance for casting	0.1253 ins./ft.
*Tensile strength	47,500 lbs./sq. in.
Elongation	3.7-4.3%
Impact value	In excess of 125 ft. lbs.
Compressive strength	90,000 lbs./sq. in.
Brinell hardness number (10 mm. ball with 500 kg. load for 30 seconds)	85
Shore scleroscope hardness	33
Rockwell hardness (red figures on E scale)	93
Specific thermal conductivity (25°-100°C)	0.253 calories/cm²/°C
Thermal expansion-per unit length (25°-100°C)	0.0000295/°C
Electrical conductivity at 20°C	136,277 Mhos/cm³
Electrical resistance at 20°C.	0.000007338 Ohms/cm³
**Temperature coefficient a...	between 20-100°C., 0.003030

*Tensile strengths in excess of 47,500 foot pounds can be obtained under certain casting conditions

**This coefficient is used in the following formula for calculating resistance at temperatures other than 20 degrees Cent.:

$$R_{temp.} = R_{20}\left(1 + [a(T-20)]\right)$$

connection with different castings. In both impact and tensile strength, zinc alloy die castings meet the requirements of many types of

Fig. 9 — Loud speaker having the appearance of wood, but produced from alloy die casting. Extensive preparatory work before finish is applied is unnecessary

service in addition to those mentioned in the foregoing. The "jimmy-proof" lock depicted in Fig. 7 is cast from the 4-3-.1 zinc alloy, and while "jimmy-proof" locks have been the aim of locksmiths—and the target for lawbreakers—for upward of four thousand years, performance indicates that the metal, at least, will live up to its name. In addition to its strength, the manufacturer has taken advantage of the easy plating properties of zinc alloy die castings to increase the sales appeal by applying an appropriate, durable finish.

Transmitting Torque by Press and Shrink Fits

By J. W. Baugher Jr.

WITH the increasing use of press and shrink fits without keys for the transmission of power and the more general realization that high localized stresses are produced at the corners of keyways and keyseats, such fits have become of considerable importance. In some cases keys are necessary to locate parts in particular positions on their shafts, but there are many instances in which keys may be dispensed with, and press or shrink fits, perhaps slightly heavier than would be used with keys, will be adequate to transmit the torque.

When a hub or ring of appreciable thickness relative to its diameter is forced or shrunk on a solid shaft of larger diameter than the bore of the ring, two principal stresses are produced in the ring: A tangential tensile stress S_t and a radial compressive stress S_c, Fig. 1. If the shaft and ring are of the same material, the maximum value of the tangential or hoop stress, which occurs at the bore is

$$S_t = \frac{Ee}{2}\left\{1 + \left(\frac{d}{D}\right)^2\right\} \quad \text{.....(1)}$$

where E is the modulus of elasticity of the material, e is the fit allowance per inch of shaft diameter, d is the shaft diameter, and D is the outside diameter of the hub. If the shaft and ring are of different materials, the maximum tangential stress at the bore is

$$S_t = \frac{e}{\frac{1}{E_1}\left(\frac{V_1}{E_1} + \frac{1-V}{E}\right)\left(\frac{1-\left(\frac{d}{D}\right)^2}{1+\left(\frac{d}{D}\right)^2}\right)} \quad \text{.....(2)}$$

where E and E_1 are the moduli of elasticity of shaft and ring respectively, V and V_1 are Poisson's ratio for shaft and ring, and e, d, and D are the same as in equation (1). The maximum radial stress, also at the bore, when the material in the shaft and ring are the same is

$$S_c = \frac{Ee}{2}\left\{1 - \left(\frac{d}{D}\right)^2\right\} \quad \text{.....(3)}$$

When the material in the shaft and ring are different, the maximum radial stress is

$$S_c = \frac{e}{\frac{1}{E_1}\left(\frac{1+\left(\frac{d}{D}\right)^2}{1-\left(\frac{d}{D}\right)^2} + V_1\right) + \frac{1-V}{E}} \quad \text{.....(4)}$$

where the symbols have the same meaning as in the preceding equations.

For steel and other ductile materials the maximum shear theory is commonly accepted as being most nearly correct. According to this theory the maximum equivalent tensile stress

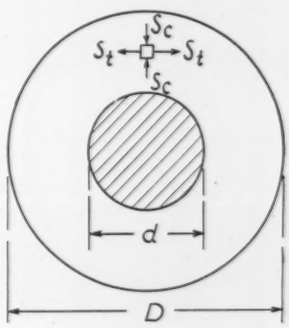


Fig. 1—Stresses introduced into a hub or ring forced or shrunk on a solid shaft

STRESSES existing in press and shrink fits and the transmission of torque by means of these fits are problems of increasing importance in design. It is certain that keys often are a constant source of trouble. The accompanying article is an abstract of a paper presented by J. W. Baugher Jr., engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., at the annual meeting of the American Society of Mechanical Engineers at New York, Dec. 1-5.

in the ring due to the combined effect of S_t and S_c is

$$S = Ee \quad \text{.....(5)}$$

This stress, which is at the bore, is also the maximum stress in the fit; therefore, this equation determines the fit allowance when the same ductile material is used in both ring and shaft.

For brittle materials, such as cast iron, it is agreed generally that the maximum stress theory is the correct theory of strength. The critical stress according to this theory is the maximum principal stress, which, as has been seen, is the tangential stress at the bore of the ring as given by equation (2). If the shaft is steel and the ring cast iron, and it is assumed that Poisson's ratio is the same for steel as cast iron, also that the modulus of elasticity of cast iron is half that of steel, this equation reduces to

$$S = \frac{Ee\left\{1 + \left(\frac{d}{D}\right)^2\right\}}{3 + V + (1 - V)\left(\frac{d}{D}\right)^2} \quad \text{.....(6)}$$

This stress is the greatest stress in the fit.

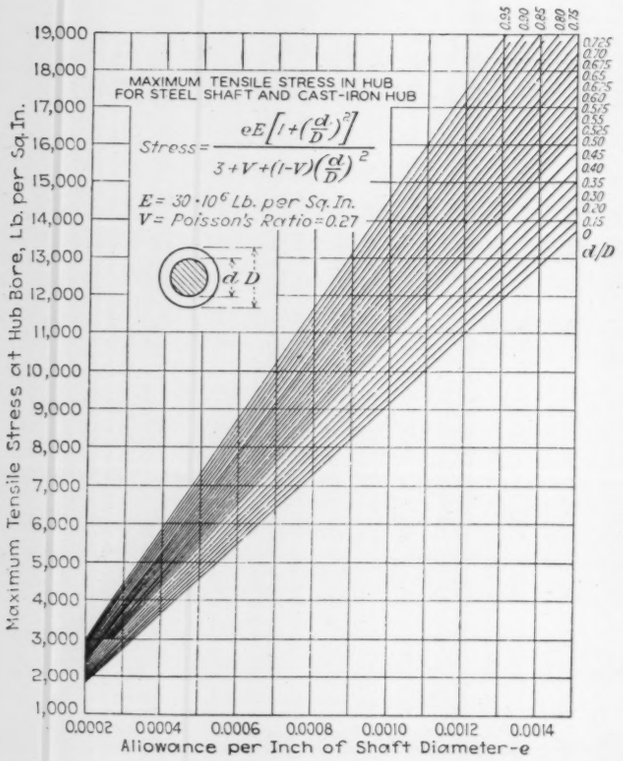

MAXIMUM TENSILE STRESS IN HUB FOR STEEL SHAFT AND CAST-IRON HUB
Stress = eE[1+(d/D)²] / 3+V+(1-V)(d/D)²
E = 30·10⁶ Lb. per Sq. In.
V = Poisson's Ratio = 0.27
Maximum Tensile Stress at Hub Bore, Lb. per Sq. In.
Allowance per Inch of Shaft Diameter-e
d/D

Fig. 2—Typical chart plotted from equation (6) useful for quickly determining the critical stresses in the fit

For an allowance of 0.001-inch per inch of shaft diameter, this maximum stress is between 9000 and 15,000 pounds per square inch depending upon the ratio d/D.

Fig. 2, a chart plotted from equation (6), is useful in determining the critical stresses. If the ring is a gear, a flywheel, or any part in which there is metal outside the actual hub, such as arms and a rim, an equivalent value of D larger than the hub diameter must be used in equation (6) and the chart. The error that results from estimating this equivalent outside diameter usually will be only a few per cent.

The pressure has the same value as the radial

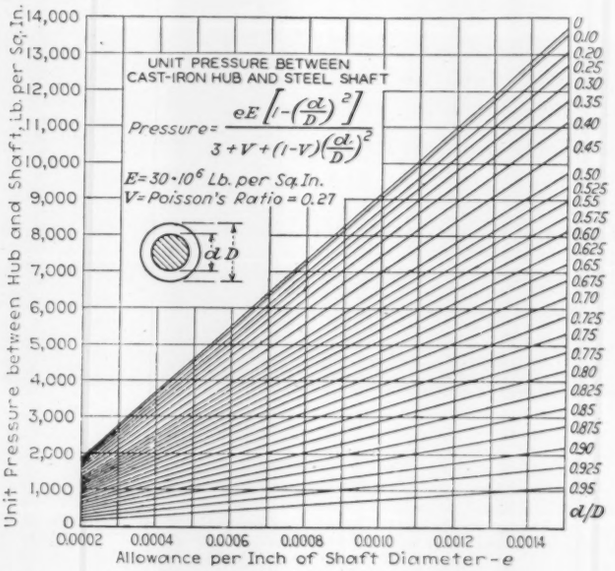

UNIT PRESSURE BETWEEN CAST-IRON HUB AND STEEL SHAFT
Pressure = eE[1-(d/D)²] / 3+V+(1-V)(d/D)²
E = 30·10⁶ Lb. per Sq. In.
V = Poisson's Ratio = 0.27
Unit Pressure between Hub and Shaft, Lb. per Sq. In.
Allowance per Inch of Shaft Diameter-e
d/D

Fig. 3—Convenience in determining pressures is provided by this typical chart which is plotted from equation (8)

stress at the bore and may be determined from equation (3) or equation (4). If the shaft and ring are of steel, equation (3) must be used. The unit pressure is therefore

$$P = \frac{Ee}{2}\left\{1 - \left(\frac{d}{D}\right)^2\right\} \quad \text{.....(7)}$$

If the shaft is steel and the ring cast iron, equation (4) becomes

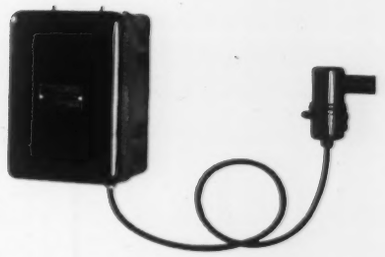
$$P = \frac{Ee\left\{1 - \left(\frac{d}{D}\right)^2\right\}}{3 + V + (1 - V)\left(\frac{d}{D}\right)^2} \quad \text{.....(8)}$$

if the same assumptions are made as in deducing equation (6). A chart such as Fig. 3, plotted from equation (8) will be found convenient in determining pressures. As with Fig. 2, an equivalent hub diameter must be used for D when the diameter of the actual hub is not the outside diameter of the outer member.

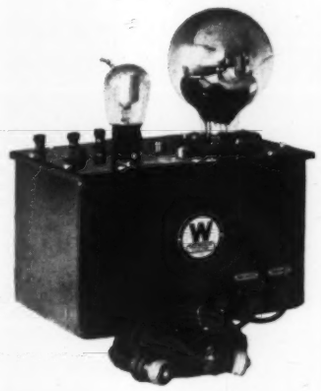
If the diameter of the hole is less than 25 per cent of the shaft diameter, however, the shaft can be considered solid and these formulas can be used with a maximum error (when d/D is zero) of about 7 per cent. The error decreases as d/D increases.

(*Concluded on page 80*)

Photo Cell Units—Application and Design



Figs. 1 and 2—Typical light sensitive devices



By Edgar H. Felix

SUPPLEMENTING the information contained in the first section of this contribution, which appeared in MACHINE DESIGN for February, it is proposed to touch upon several other applications of photoelectric units and to give also sufficient data on the design of the component parts to enable the reader to form a conclusive understanding of the equipment.

Laboratory investigations have shown that the photoelectric cell can be used to perform chemical analyses of various kinds far more rapidly and economically than chemical tests. The presence of impurities in liquid chemicals is accompanied almost invariably by minute color changes, frequently invisible to the eye. Such a critical color having been determined, the amount of light of that color which can be transmitted through the liquid then is measured with the photoelectric cell. Large quantities of material can be tested rapidly in this manner. Chemical tests, on the other hand, usually require a great deal of time.

Photoelectric Test Prevents Variation

A printing ink concern found it impossible to satisfy a customer in furnishing him with a certain type of red ink. The customer insisted each time a new batch was delivered that it did not match that delivered on the preceding order. The ink manufacturer knew, however, that there was no variation because photoelectric color analysis proved the precision with which the color was maintained. The customer was found to be comparing the samples of freshly printed material with old and faded samples of jobs finished months previously.

The textile industries have been particularly alert to the possibility of applying light sensitive devices in color matching. Spectrophotometers have been developed which enable a normally intelligent operator to obtain an accurate color frequency curve of a dye or color.

Most color matching in textile dyeing is done by experienced workers who have matched samples for years. A curve of the color composition of the sample to be matched based on a scale of Angstrom units has little or no significance to such practical men. The foreman who passes upon the match made with the sample merely advises the addition of a little dye of one color or another with no knowledge of color frequency. To take advantage of photoelectric color analysis the dye foreman must learn a new language and become familiar with entirely new units in color measurement. But once the practice is established on a basis of scientific measurement rather than highly skilled human judgment, much more reliable results can be secured.

The design of light sensitive units usually involves four major elements: (1) the optical system; (2) the photoelectric cell; (3) the vacuum tube amplifier and (4) the output device. Although these elements cannot be treated ex-

IN this article, the second section of a timely and pertinent contribution on photoelectric equipment, considerable information is given on design of the actual units. The earlier article, in the February issue, covered fundamentals and classes of light sensitive devices, and many interesting applications. Close study of these discussions is well worth while in view of the immense field opening up for photoelectric apparatus.

haustively in this article, it is possible to give a general outline of the design, capacity and general problems encountered in their development. Inasmuch as we wish our electric brain to respond to a particular kind of light stimu-

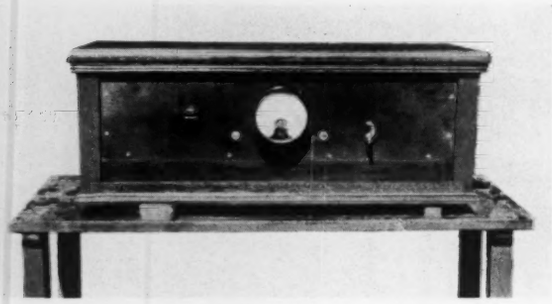


Fig. 3—Portable photoelectric measuring device for determining total reflection

lus, it is essential that the illumination to which the photoelectric cell is submitted varies in accord with the condition we desire to control. This involves the design of an optical or illumination system of a character limiting light fluctuations to the element which it is desired to measure or which is to be used for control purposes. For example, it is obvious that if we are to use a light sensitive device to shut off an electric sign at sunrise, we should place it in a position such that the rays of the rising sun fall upon the photoelectric cell and furthermore, that no interfering light source, such as that produced by the oncoming headlights of an automobile, should operate the device. If we desire to detect the presence of a green impurity in a liquid, we shield the photoelectric cell from every kind of light except green by means of suitable color filters.

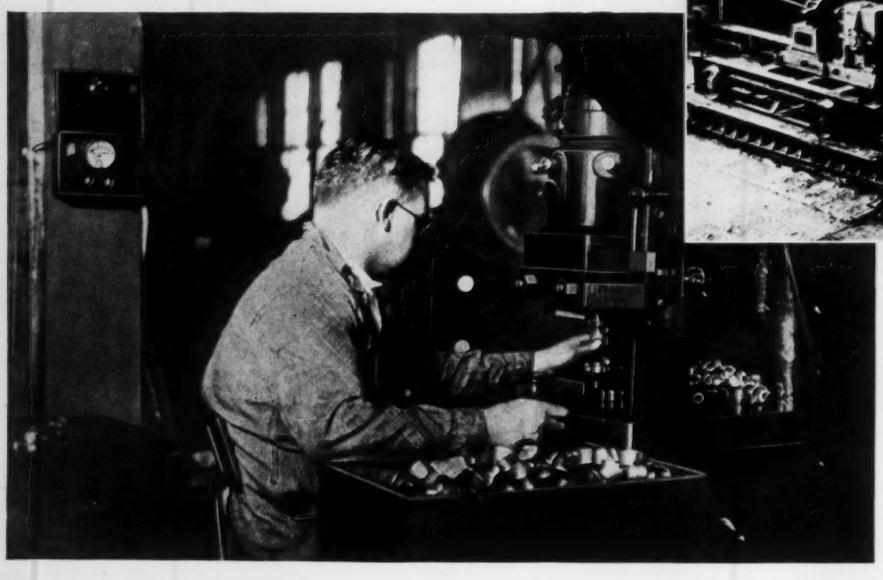
In other applications it is desired that the cell should not respond to room illumination but must work with equal facility in darkness or daylight. In that case the photoelectric cell is housed in a light-proof box and equipped only with a small opening upon which a bright beam of light is focused. The percentage change of illumination on the cell brought about by changes in normal illumination then is insufficient to operate the cell. If, however, a person or object intercepts the powerful light beam focused on the cell, the change is sufficiently substantial to operate a warning signal or any desired control.

Sometimes the isolation of light fluctuations to the specific element which it is desired to utilize and the exclusion of extraneous sources of light variations involves unusual and difficult optical problems.

The Photoelectric Cell

The second major element of the light sensitive system is the light response element itself. Any substance which changes its electrical characteristics in response to light stimulus is said to possess photoelectric properties. Some substances, such a selenium stibnite and cuprous oxide, change their resistance in response to light. The alkaline metals, such as zinc, potassium, caesium and rubidium, on the other hand, release electrons in response to light. Such emission of electrons is facilitated by surrounding the light sensitive material by a high vacuum. The addition of a small quantity of inert gas in a photoelectric tube effects considerable increase in the available output.

By suitable combination of photoelectric substance and co-operating atmosphere, photoelectric cells possessing the characteristics required



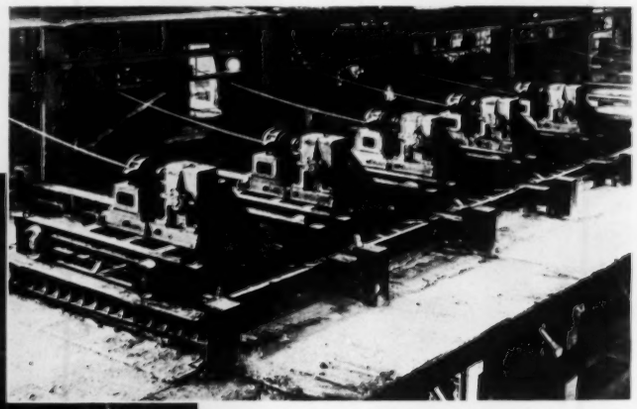


Fig. 4—(Left)—Photoelectric control installed on a punch press. Operation of the press is prohibited if operator's hands are within range of the cell. Fig. 5—(Above)—Soaking pit covers in steel mill are removed by use of a photoelectric unit

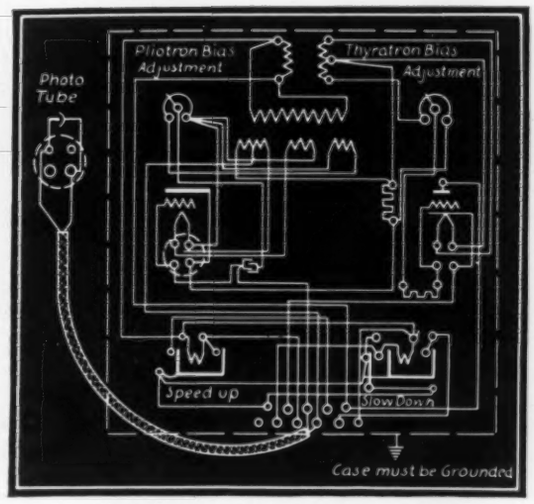


Fig. 6—Wiring diagram for paper registering control on a wrapping machine

by the problem in hand can be produced. In general, the alkali metals are photoelectrically sensitive to a range of light frequencies according to their electro-positiveness as shown in the periodic table of the elements. Sodium, for example, is most sensitive to the shorter light waves in the blue-violet portion of the spectrum; potassium responds to longer waves, rubidium to still longer and caesium to the longest visible light waves bordering on the infra-red. Photoelectric cells are available commercially covering a wide range of specifications as to sensitivity, frequency or color response and output produced.

Amplifier systems associated with photoelectric cells also are available in commercial form. Their function is to increase the minute fluctuations constituting the output of the photoelectric tube to the magnitude required by the output device used. Through long experience in the communication field, the design of amplifier systems is a highly developed technique.

However, an amplifier is unnecessary when it is desired merely to open or close an electrical circuit at a given value of illumination of the photoelectric tube. Its output then is applied to a grid glow tube or other sensitive electron relay. Once the path through such a tube is established by the application of the breakdown voltage, it remains conducting until readjusted.

Output Devices and Recording

In many instances, the only objective of photoelectric measurement is to obtain accurate comparison of the color of samples or specimens without directly controlling any operation as a result of the comparison. That purpose is served merely by measuring the current output of the amplifier system with a meter of suitable range. Many laboratory applications of the photoelectric cell are nothing more than its utilization as a light measuring device, a function which it performs satisfactorily.

A permanent graphic record of output readings is secured by the obvious expedient of using a recording meter. It is possible to control a series of relays each of which operates when a predetermined value of illumination is reached. Thus articles may be graded into groups according to their color or shading.

Possibilities Are Unlimited

In the foregoing, many specific applications of light sensitive devices have been mentioned. But any list fails to indicate their potential applications. The fact is that any single discrimination made by the human eye which can be segregated through a suitable optical system may be accomplished by a light sensitive device and in turn used to control any operation which can be made to follow the dictates of an electric current. We are entering upon what amounts to a new era in machine design substituting electrical judgment for human judgment just as we already have substituted electric power for drudgery. Indeed as these automatic processes have been substituted more and more for labor, we have placed heavier burdens and responsibilities upon human inspection. The most antiquated element of the industrial structure is the reliance we place on human

Fig. 8—Photoelectric hydraulic door opener which operates by passage of individual toward the door

vigilance. Now, however, the light sensitive device is waiting for application wherever we find too great a burden imposed upon human judgment. Only with so broad a generality is it possible to describe the extent of the field lying before the photoelectric cell.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments from Our Readers. Machine Design Will Pay for Letters Suitable for Publication

Overcoming Filing Difficulties

To the Editor:

ONE of the chief difficulties encountered in the engineering department is that of keeping track of drawings so that they may be available on short notice. This applies principally to those systems where original drawings or tracings are handled by designers and draftsmen for reference or similar use. In the October issue of MACHINE DESIGN a number of efficient filing systems was described. A simple method for locating drawings taken from the file is provided by requiring each person removing a drawing to record the number, date, and his name on a card which is filed by the vault attendant.

Unwanted Drawings Accumulate

Unless there is some means of reminding the men to return drawings to the vault when they are no longer required, they are apt to accumulate at the draftsman's board. A good scheme to minimize this trouble is to have simultaneous, periodic clean-outs of all storage places. At this time all unwanted drawings are returned to the vault and new record cards made out for those retained. By appointing specified days, such as the first and third Mondays in the month, for the clean-out there is a tendency for a habit of co-operation to be formed. Drawings that appear to be lost when an ordinary search is made, often turn up on "Clean-Out Day" and the few minutes spent by the men in making out new cards is well repaid. When drawings are returned to the vault during the intermediate periods, they are filed immediately and the record cards destroyed.

Another useful practice which minimizes the evils due to misfiling of drawings is to go through every drawer and put misfiled drawings in their proper places. If this is done once in six months and if each alternate check-up is carried out in conjunction with a special clean-out in which *all* drawings are returned to the vault, a record can be compiled of drawings that are lost. The discovery of the loss before too much time has elapsed, makes it possible to replace the lost drawings by retracing from the latest blueprints. Until such replacement drawing has been made, a named and numbered dummy sheet carrying the word "MISSING" can be filed in place of the drawing.

—W. S. BROWN,
Auburn, N. Y.

Dividing an Annulus

To the Editor:

THERE are many cases in engineering where parts are made with an annulus cross section; that is, a body of revolution, straight or curved in radial planes, symmetrical or unsymmetrical on a normal to the axis of revolution. This classification includes hubs of steam turbine disks, large gears with web sections, hydraulic channels of centrifugal pumps, water turbines, turbo-air compressors, and the like, not to mention many types of shafts with flanges forged on them. In disks, gears and shafts, the parts constituting the annulus often transmit heavy loads, and, therefore, the

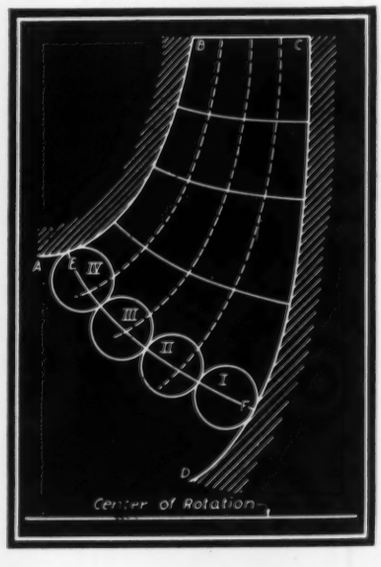


Fig. 1—Typical pump or compressor impeller profile which is to be divided into equal area channels

stresses therein are investigated carefully. In the case of centrifugal pumps, water turbines, and air compressors of the rotary type, the annulus forms the carrying channel for the water or gas, and its areas are proportioned carefully to avoid choking in the passage.

A typical pump or compressor impeller profile which is to be divided into equal area channels to check the flow conditions is shown in Fig. 1. The same process used in this analysis serves for strength investigations in disks, etc. Once the section is divided, the stresses or velocities are found easily by simple, well known formulas, but the dividing is usually the laborious part of the work, often consuming many hours of trial and error, and introducing the possibility of

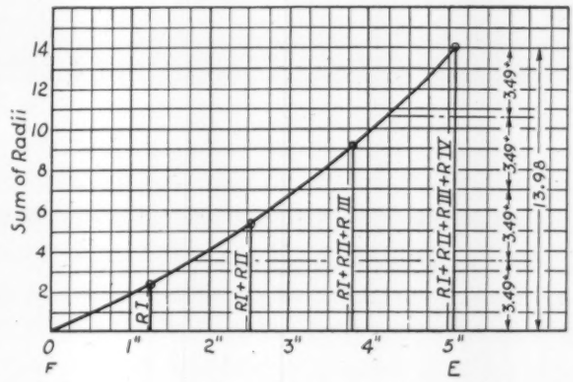


Fig. 2—Graphical set-up to be used in dividing areas into equal parts

error in the final result which might necessitate going over the whole thing again. The method described is deliberate, gives direct results without any trials, and usually requires about a fifth of the time otherwise spent.

In Fig. 1, *A-B* and *C-D* are the channel walls between which the liquid flows. The annulus area is the sum of all parts such as $2\pi R\,dx$ along the curve-normal *E-F*. Channels are usually divided into from four to ten part-channels; in our illustrative case we will use four. The more divisions used the more accurate the work will be. In order to make the solution perfectly general and avoid finding curve equations, etc., we will use graphical methods which greatly expedite the work.

Let it be required to divide the channel into four equal area parts. If *E-F* measures 5.05-inch, one-fourth of *E-F* would be 1.26-inch. Draw in four circles each of 1.26-inch diameter, as shown in Fig. 1, and number them I, II, III, and IV. Tabulate the radii of such circles, measured from the center of rotation, as 2.41, 3.03, 3.79 and 4.75-inch respectively.

Now take a sheet of cross section paper and lay off to any convenient scale the length *E-F* divided into four parts of 1.26-inch each, see Fig. 2. As ordinates, plot the radii as shown, the first ordinate being radius I, the second being the sum of I and II, the third the sum of I, II, and III and the fourth the sum of all four radii. Draw in a smooth curve taking care that it follows the direction of the plotted points. This curve may take a variety of shapes according to the section investigated. Divide the sum of the four radii, which is the last ordinate, into four equal parts, each part being approximately 3.49-inch in length. Project these to the left and scale off these intersections from zero: they measure 1.72, 3.05, 4.19 and 5.05 inches respectively. These are then laid in along the curve in Fig. 1 from *F* towards *E*, and form the limits of the equal area channels. Proceeding similarly for the other curve normals we finally get a series of points lying on the dotted curves shown in Fig. 1. On any normal that is parallel to the axis of revolution, the part-channels all will be of equal width. Velocities or stresses now can be computed easily.

Work Is Easily Proved

The proof of the work is simple: Dividing *E-F* into n equal parts of x width, the Area $= \Sigma(2\pi R\, n\, x)$, R being the only variable. Since the other factors constitute a constant proportionality factor which we may drop, we have the result that the area is proportional to the sum of the radii used. Dividing the sum of the radii into n equal parts, which we did, and projecting them on the curve of Fig. 2, the intersections give the limits of the channels.

Comparing the stresses or velocities, it will be found that they are inversely proportional to the product of the radius and channel width at any given point. Therefore, concentrations of stress or choking of flow can be located easily.

—JOHN S. CARPENTER,
Hanover, Pa.

Issues 1930 Standards Index

THE third issue of the annual index to American Society for Testing Materials standards and tentative standards in effect as of September 1930, recently was issued by the organization. A complete list of the 427 standards and 155 tentative standards covered by the index appears in the 1930 A. S. T. M. Year book, and in both parts of the 1930 book of standards.

As stated in the foreword, the index is designed to be of service to those familiar with the society's standards in locating any specification or method of test in the bound publications in which it appears, and as well, to those interested in ascertaining if the society has issued any standards on a specific subject. Copies will be furnished, upon request, without charge, by the American Society for Testing Materials, 1315 Spruce street, Philadelphia.

MACHINE DESIGN

Editorial

To Design for Specific Market Is Good Business Policy

IN THIS period of low prices, the American public is looking for big values for little money. Alert manufacturers are recognizing this attitude on the part of consumers, with the result that more and more products are being designed, produced and distributed to meet specific market requirements.

Evidence of this trend is found in the recent action of makers of washing machines, electrical refrigerators, sewing machines, and similar mechanical devices in establishing several grades of each product. They offer a de luxe model for consumers who want luxury, a slightly less expensive machine for those with moderate incomes and perhaps other models for those demanding lower prices.

Designing to the specifications dictated by these various price ranges taxes the resources of engineers to the limit. Here the problem often is one of striking a delicate balance between quality and price. The designers best equipped to handle problems of this type are those who have the best working knowledge of available materials, purchased parts and accessories and methods.

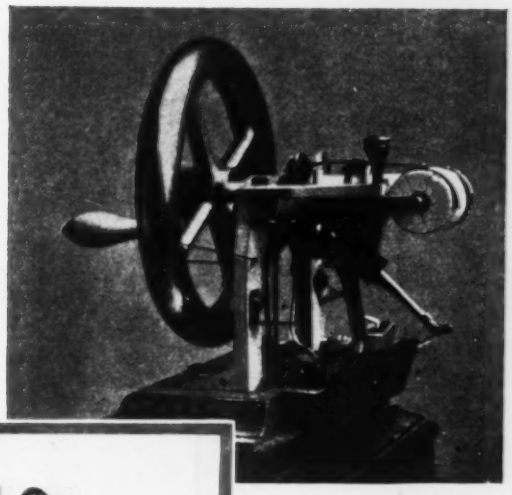
The real test of superlative ability in machine design seldom will be found in the creation of a de luxe mechanical product. It is more likely to be encountered in the development of an article in which the factors of serviceability, simplicity, and practical mechanical perfection must be combined with economy. Engineers who have the skill to place the proper emphasis on these conflicting considerations will be in demand during the present era of bargain purchasing.

This Machine Age!

IS MODERN machinery destined to be a curse or a blessing? Views are extremely divergent on this point, many claiming that the present depression and unemployment are the result of development of machinery, others that advanced civilization and its advantages would be retarded considerably without such development; and others that automatic machinery assists in creation of new industries with consequent increases in employment figures.

In the leading article in this issue, a symposium is presented. This and other discussions of the subject cover an absorbing topic, yet we are convinced that one course inevitably will be pursued—that engineers always will feel the urge to design and redesign to the best of their ability, remembering that on their resourcefulness and ingenuity depends the progress of modern civilization and that: "He who steps not forward, moves backward."

Design Progress in Domestic Sewing Machines



Photos, courtesy White Sewing Machine Co.

Invention of the sewing machine by Elias Howe in 1845 brought only grief to the inventor for some years. His patents were infringed, resulting in law suits. Howe won these and reaped a fortune of several million dollars. At top is shown his first practical machine; left, a model of the nineties with iron base and treadle; center, one of the popular electrically driven console models of today

NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

POSITIVE register of sheets in a feeding mechanism is provided by a transfer gripper device patented recently by Joseph R. Blaine, Oak Park, Ill., and assigned to Miehle Press & Mfg. Co., Chicago. The patent number is 1,790,457.

While the invention may be applied to any kind of sheet handling machinery, it is particularly adapted for use in connection with printing presses. The usual application is where a sheet carrier is provided which comprises one or more sheet engaging grippers arranged to oscillate between sheet supporting means and the printing couple of a press for the purpose of transferring a sheet of material from one to the other. The mechanism also will permit the feeding of sheets at an exceedingly high rate of speed without impairing the accurate register of sheets fed.

The sheet transfer means is mounted on a rock shaft 10 which preferably is arranged above the impression cylinder 11 and the front edge of the feed board 12 of the press. The sheet transfer grippers 13 and co-operating gripper pads 14 are actuated by cams 17 and 18.

The shaft is oscillated through a predetermined angle by means of the driving mechanism, whereby the bracket 19 will move from the position shown in Fig. 1-*B* to the position indicated in broken lines in Fig. 1-*C* and vice versa. The cams 17 and 18 preferably rotate at a constant speed in the direction indicated by the arrows. Cam 17 is so timed that the grippers will be closed when the bracket reaches the positions in Fig. 1-*B* and will maintain the grippers closed until it reaches the position shown in full lines in Fig. 1-*C*, at which time the sheet carried by the grippers will be taken over by the cylinder grippers, or by equivalent means.

From the time the grippers engage the sheet, at which time the shaft will commence its motion in a clockwise direction to the position indicated in Fig. 1-*C*, the speed of the bracket and of the grippers 13 and pads 14, will be accelerated gradually so that when the grippers of the cylinder take over the sheet, the latter will have reached the surface speed of the cylinder. The driving mechanism used to operate the shaft does not form a part of this invention but is the subject of a separate application, serial No. 324,476 filed Dec. 7, 1928, by A. G. Jacobson.

VARIABLE speed control of clutches, servomotors and the like is provided in a device patented by Harry L. Tanner, Brooklyn, N. Y., number 1,784,504, and assigned to Ford Instrument Co. Inc., Long Island City, N. Y. This speed control mechanism is efficient for readily following and transmitting variable speed motion, and for amplifying the power input to any desired degree.

The vibrating member controls the unit served by rapidly varying its energization proportionally to the movements of the primary elements.

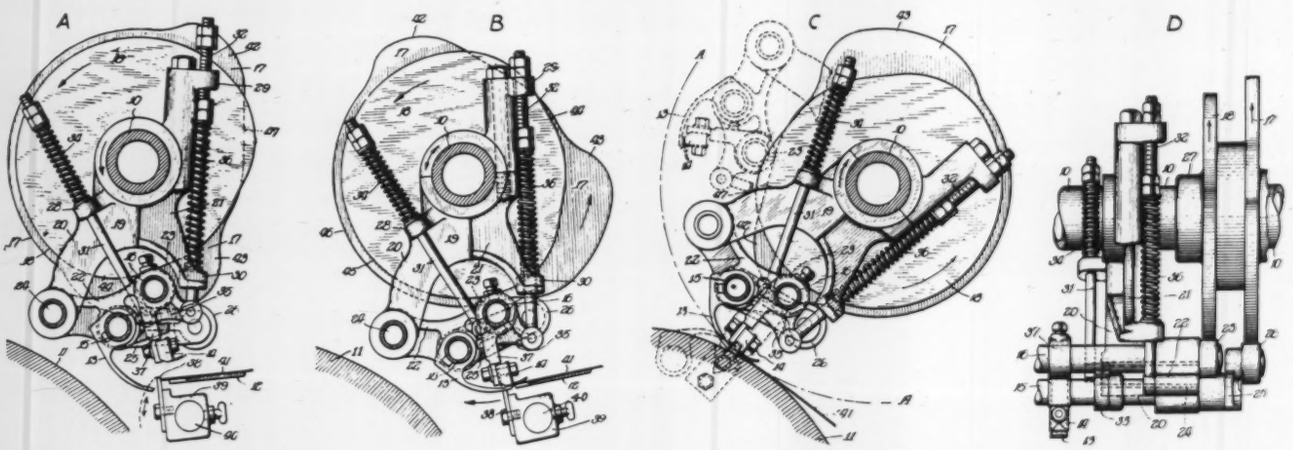


Fig. 1—Successive movements of the sheet feeding mechanism as it transfers sheets from the feed board to the grippers on the cylinder

The members controlling both forward and reverse directions of movement are energized by the vibratory made-and-break action, but for varying lengths of time depending upon the direction of movement of the primary.

Application of the device to the movements of the gyroscope is shown in Fig. 2. The gyroscope 37 is suspended in a gimbal ring in the usual manner. One of its trunnions carries an integral resilient crank arm 40 the end of which is bifurcated and carries the contact roller 1 which is connected to one side 2 of an electrical supply line and insulated from the remainder of the arm. Thus the primary or followed element comprises the gyroscope 37, arm 40 and contact roller 1.

The secondary or following element of the system may be journalled in the rigid standard 41. The shaft 42 carries an integral crank arm 43 upon which are the vibrator magnets 9.

Movements of the gyroscope 37 as transmitted to roller 1 effect the energization of clutch coils 20 or 21 by closing the circuit through either one

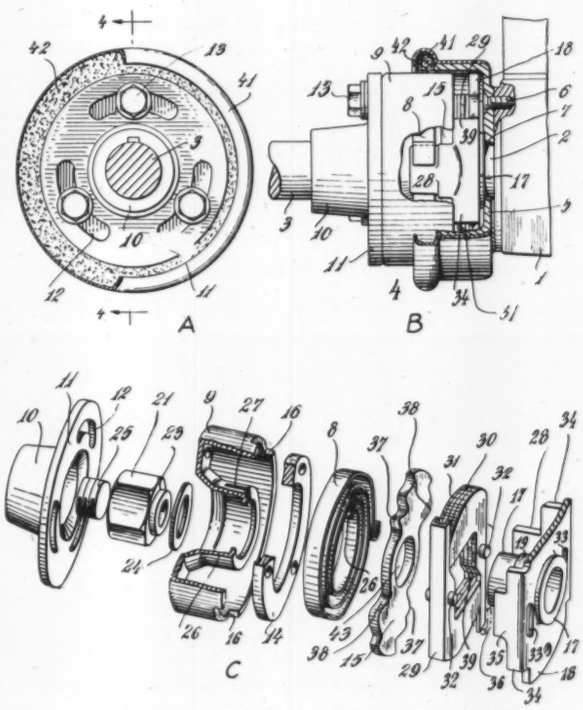


Fig. 3—A—Front view of the impulse coupling. B—Side view partly in section. C—Parts used in their relative positions

of contacts 5. The central clutch ring 45 grips either gear 49 or 50 and thereby drives it, obtaining its power from motor 46. This motion is transmitted to shaft 42 and arm 43 to move vibratory commutator 4, pivotally mounted on arm 11, bodily in the same direction that roller 1 has been moved. This tends to return roller 1 to a central position between contacts 5, when it is actuated by movements of the gyroscope either in a continuation of the direction of movement or in reverse. The motion is smooth,

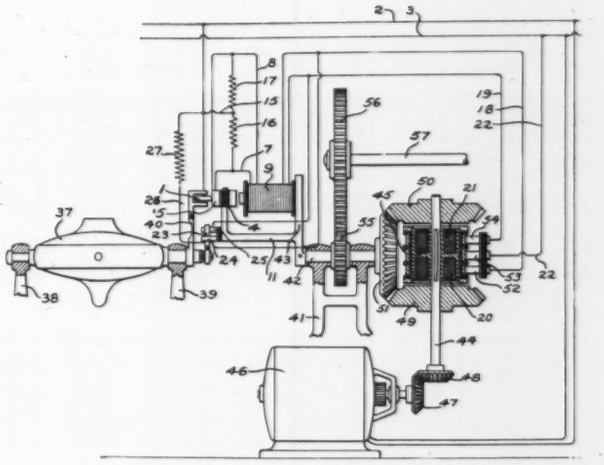


Fig. 2—Wiring diagram for speed control device as applied for transmitting the movements of a gyroscope

and continuously follows the movements of the primary elements.

MOMENTARILY accelerated movement can be imparted to a driven member by the application of an impulse coupling recently patented by John D. Martin, Springfield, Mass., patent number 1,788,062. The coupling is a self-contained drive primarily intended to connect a magneto to a drive shaft of an engine and actuate the magneto at starting with sufficient quickness, to produce a good sparking current.

The coupling, Fig. 3, comprises a casing to be keyed at 10 on the drive shaft 3 and a cover 5 affixed to the framework of the magneto 1, which has an armature with a shaft 2 projecting out through the cover and joined to the drive shaft by a suitable spring 8 in a casing 9. The cover 5 has one or more stops 36 inside and the coupling 4 includes one or more releasable catches 29, rotatable with the armature shaft to engage stops and thus arrest the armature.

Stops Hold Catches, Tension Spring

As the catches 29 revolve and the shanks 31 come into vertical position, they drop of their own weight until their studs 32 come to rest in the lower ends of the slots 33 in the plate 18. As rotation continues, the stop 36 retards the plate 18 and shaft 2, while the shaft 3 puts the springs 8 under tension. Next the adjacent cam point 37 of the element 15 engages the stud 32 on the arrested catch and moves this catch upward. As soon as the shank 31 is clear of the stop 36, the spring throws the plate 18 and the armature forward with the accelerated speed necessary to produce the spark.

This function is performed twice for each revolution of the armature, but ceases when the engine reaches the desired number of revolutions per minute, whereupon the magneto will be driven in the normal manner.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

RECOGNITION of years of service and exceptional achievement in the design of electrical equipment was accorded recently to Frank D. Newbury, by his elevation to the post of general manager, machinery engineering department, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Mr. Newbury, who received the degree of mechanical engineer from Cornell university in 1901, first worked for Westinghouse during his junior year vacation. After graduation he took this company's apprenticeship course, and in 1903 joined the engineering department.

Mr. Newbury, successively, handled alternating current generator design, was in charge of the design of generators, synchronous motors and rotary converters, became assistant division engineer and later engineer of the power division, and in 1920, was made manager of the power engineering department. The present lines of standard alternating-current generators, synchronous motors and converters were developed under his supervision.

Mr. Newbury was a manager of the American Institute of Electrical Engineers for four years, 1918-1922, and has been active in the committee work of the institute. He also is a member of the American Society of Mechanical Engineers, National Electric Light association, and Sigma Xi fraternity.

A LEADER in automotive design for twenty-nine years, Col. Howard C. Marmon, vice president in charge of engineering, Marmon Motor Car Co., Indianapolis, recently was accorded additional recognition by the award of a medal by the metropolitan section, Society of Automotive Engineers, for the year's most noteworthy automotive accomplishment in the development of passenger cars. The award was made to Colonel Marmon for his design of the 200-horsepower, all-aluminum engine, used in the new Marmon Sixteen.

Born in Richmond, Ind., in 1876, Colonel Marmon first worked as a millwright in the factory of Nordyke & Marmon, manufacturers of milling machines. Even his first car, designed in 1902, incorporated many noteworthy features which later became standard practice in the industry. Among these first contributions were: Force feed lubrication of engine bearings; selective-type sliding gear transmission; straight-line drive from engine to rear axle; and multiple disk clutch.

The government sent Colonel Marmon to Europe during the World war to select airplane equipment, and his services were enlisted later in the development of the Liberty motor. A few years ago when the straight-eight cars came into popularity, the industry was confronted with the problem of carburetion and manifolding, the solution of which was found to be in the duplex down draft manifold, a development of Colonel Marmon's.

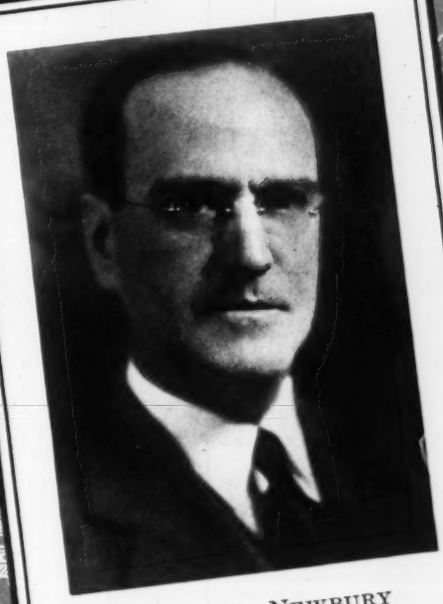
EXTENSIVE research on cast iron, tungsten, thorium, and the transformation of austenite has won for Edmund S. Davenport the Robert W. Hunt medal of the American Institute of Mining and Metallurgical Engineers. He is a member of staff, research laboratory, United States Steel Corp., Kearny, N. J., and at present is engaged in metallurgical research.

After graduating from the Sheffield Scientific school of Yale university, and subsequently taking two years of graduate work in metallurgy leading to degree of M. S. in 1921, Mr. Davenport entered the employ of the Eastern Malleable Iron Co., Naugatuck, Conn., as research metallurgist. From 1922 to 1929, he was metallurgist, Westinghouse Lamp Co., Bloomfield, N. J.

Mr. Davenport is the author of several papers that have appeared in *Transactions* of the American Institute of Mining and Metallurgical Engineers, and the American Foundrymen's association. His latest contribution to technical literature is a paper, prepared with E. C. Bain, United States Steel Corp., entitled "Transformation of Austenite at Constant Subcritical Temperatures." He is a member of the A. I. M. E., American Society for Steel Treating, Yale Engineering association, and Phi Sigma Kappa fraternity.

DEVELOPMENT of designs for steel castings whereby one casting will take the place of a number of built-up parts is one of the principal interests of W. H. Worrilow, president, Lebanon Steel Foundry, Lebanon, Pa.

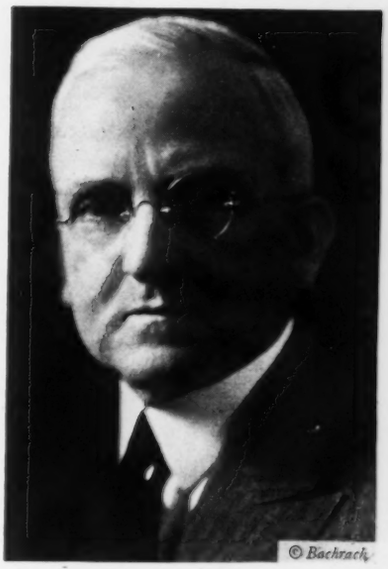
Leaders in Design, Engineering and Research



FRANK B. NEWBURY

HOWARD C. MARMON

EDMUND S. DAVENPORT



WILLIAM H. WORRILOW

Mr. Worrilow, recently elected president of the Steel Founders Society of America, entered the steel casting field in 1892, at the plant of the Standard Steel Casting Co., Thurlow, Pa.

During the following 12 years, he occupied about every position a foundry has to offer, proceeding to the position of assistant district manager at Pittsburgh for his company, which had become the American Steel Casting Co. After seven years, 1904-1911, devoted to sales work with other companies, Mr. Worrilow formed the Lebanon Steel Foundry with T. S. Quinn. It was with this company that he was able to utilize his extensive experience to satisfy the growing demand for small steel castings. His present activities in the promotion of design tend toward the use of an integral unit rather than an assembly of several pieces.

Mr. Worrilow has been identified with the Steel Founder's Society of America during practically its entire existence, representing the Solid Steel Casting Co., in its early days, and vice president and chairman of the eastern division of the society up to the time of his elevation to the presidency. His outside interests include his church, Boy Scout activities, and two golf clubs.

* * *

Robert K. Jack, former chief engineer of the Olds Motor Works, has been selected as the chief engineer of Durant Motors Inc., Detroit. Mr. Jack started his engineering career with Argyll Motors Ltd., Glasgow, Scotland, and was one of the engineers who planned the General Motors proving grounds. J. F. Howard, who has been with the Durant company for six years as body engineer, will be assistant to Mr. Jack.

* * *

Howard Butt has been made manager of the engineering and export department of William Powell Co., Cincinnati, manufacturer of valves and engineering specialties. Headquarters for the department will be in New York.

* * *

Augustus Wood, from 1915 to 1920 chief engineer and works manager of Niles Tool Works, Hamilton, O., has returned to that organization as consulting engineer. During the past ten years he has held positions as works manager of Putnam Machine Co., Fitchburg, Mass., and consulting engineer for the parent company, Manning, Maxwell & Moore Inc., New York.

* * *

Oscar Junggren, engineer of the Schenectady works of the General Electric Co., was one of the outstanding recipients of recent awards provided by the Charles A. Coffin Foundation. He has designed steam turbines of largest capacities, those in excess of 100,000 kilowatts of his design aggregating a total of 1,323,000 kilowatts, and was the engineer who created the vertical compound turbine.

* * *

Leon Smith has joined the engineering organization of De Vaux-Hall Motors Corp., Grand Rapids, Mich., and will be in direct charge under Col. Elbert J. Hall.

* * *

Roy Wilkins has been appointed vice president in charge of engineering of the Pacific Electric Mfg. Co., San Francisco. Mr. Wilkins joined the organization Jan. 1, 1928.

* * *

C. R. Messinger, formerly president of the Chain Belt Co., Milwaukee, has been elected president of the Oliver Farm Equipment Co., Chicago. Clifford F. Messinger, formerly vice president and general manager of the Chain Belt Co., Milwaukee, has been elected president, succeeding his brother C. R. Messinger.

Obituaries

SIR CHARLES PARSONS, 76, inventor of the steam turbine, died Feb. 11 during a cruise in the West Indies. The turbine represented only one of Sir Charles' many engineering achievements, he having shown from early boyhood a talent for science and invention. The experiments which led to the perfection of the steam turbine were started in 1884 after he had served his apprenticeship in the Elswick works of Lord Armstrong. His first turbine produced 10 horsepower and made 18,000 revolutions a minute. He first began adapting his turbine to ships in 1893.

* * *

PHILIP KEMPTER, pioneer in the development of metal stampings in the United States and works manager of Geuder, Paeschke & Frey Co., Milwaukee, died Jan. 26, after a long illness. He was aged 64 years and had been associated with the company for the past 33 years. Mr. Kempter was known wherever steel stampings were used, and was the contributor of an article, "Can Metal Stampings Be Employes?" appearing in the May, 1930, issue of MACHINE DESIGN.

Responsible for the development of many of the metal stampings used by the automobile industry, Mr. Kempter is credited with having made the first steel oil pan for motors cars. He had been recognized for many years as an expert in problems of deep drawing of metal and had developed successfully many intricate stampings. He was born in Galena, Ill.

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

METAL producing, fabricating and working industries focussed their attention, during the week of Feb. 16, on the Pacific Coast where the second biennial Western Metal Congress was setting new records in interest, subject matter of papers and attendance. The congress, sponsored by the American Society for Steel Treating and twelve co-operating societies, comprehensively discussed many design problems including corrosion and lubrication difficulties, treatment of parts, and welding.

Improper heat treatment or manufacturing methods are quite often the causes of failures in machine parts attributed to fatigue, according to a paper presented by L. T. Holt, consulting physical metallurgist, Seattle. The author pointed out that no two failures can be attributed to the same cause, except when the design itself is at fault. Common causes, for failure are notch fatigue, corrosion, insufficient heat treatment, and tool marks. Many steel parts have developed cracks as a result of nonmetallic inclusions, improper fillets, tool marks left by hogging cuts, or poor machining operations.

Paul Jeffers, structural engineer, Los Angeles, brought out at the meeting that welding, unless done under proper conditions, produces a coarse grained structure which has small resistance to impact and fatigue. A fine grained structure is desired.

Corrosion of lubricated valves is a serious problem, according to George F. Scherer, director of research, Merco Nordstrom Valve Co., Inc., New York. The valves usually are lubricated by a pressure system and it is imperative that the valve be so designed that the lubricant will reach all parts requiring lubrication. Furthermore, lubricants must be chosen wisely to resist chemical action with the liquids or gases passing through the valves.

* * *

Develop New Uses for Tin

DETAILS of tin research during 1930, resulting in the development of new industrial uses for the metal, recently were announced in London by Col. S. Heckstall-Smith, secretary of the tin research and industrial applications committee of the Tin Producers' association. Among the projects undertaken was that of developing the uses of white metal bearings with a high tin content, and demonstrating the weaknesses of lead bearings hardened without tin.

A successful method also was studied whereby the problem of tinning cast iron can be overcome with the aid of a special flux mixed with powdered tin. This is said to be of much importance to bearings of diesel engines and other machinery.

* * *

Diesel Engine Demand Grows

PIPE lines, tankers, fishing boats and private yachts have stimulated the demand for diesel engines during the past year to a degree not appreciated by other business, according to B. B. Williams, president, Cooper-Bessemer Corp., Mount Vernon, O. The numerous large pipe lines for transporting natural gas, petroleum, and gasoline have required an unusual number of gas and oil engines as well as gas compressors and oil pumps.

The number of private yachts built and equipped with diesel engines during the past year is larger than in any previous period. Various construction projects already under way, together with an improvement in the market for securities, will result in considerable demand for power machinery and equipment during 1931, Mr. Williams believes.

* * *

American Standards Association Is Active

BEGINNING of work on the development of national standard specifications for leather belting to permit the purchase on a scientific basis of the $30,000,000 worth of leather belting for driving machinery required annually by industry has been approved by the American Standards association. General adoption of national standards for belting would result in savings of several million dollars annually.

Work on the project will be undertaken immediately by a technical committee made up of representatives of manufacturers, distributors, large industrial users of leather belting, and government departments. The American Society of Mechanical Engineers will direct the technical work of the committee.

Other activities of the American Standards association include adoption of American stand-

ard dimensions for Woodruff keys, keyways, and cutters. These were approved by the association following submittal by the American Society of Mechanical Engineers, which is in charge of the technical committee on this project. The standard covers a series of 27 keys of various thicknesses having radii of curvatures ranging from ¼ to ¾ of an inch. This series is said to cover 90 per cent of the requirements of the entire consuming industry.

The standard is being published by the American Society of Mechanical Engineers and copies may be ordered through this society or the American Standards association at 29 West Thirty-ninth street, New York.

* * *

Power Engineers Discuss Fatigue of Metals

POWER and its relation to business economics occupied chief interest at the fifth Midwest Power Engineering conference and the fourth national fuels meeting of the American Society of Mechanical Engineers, Chicago, Feb. 10-13. The Midwest Engineering exposition simultaneously presented a cross section of the late developments in power machinery and appliances.

L. W. Spring, Crane Co., Chicago, discussing "High Temperature Metals for Power Plants," brought out that besides its relation in insufficient tensile strength for fiber stresses and to take care of "creep," the question of metal fatigue often is brought up. While fatigue of overstressed metal is an extremely important factor at the lower temperatures, it becomes a much less serious factor as the temperature of operation rises.

* * *

Form Clearing House for Machine Design Data

TEACHERS of machine design in colleges and technical schools have formed a "clearing house," the purpose of which is to exchange problems in machine design, research data, ideas as to methods of teaching machine design, and other information of mutual interest. Material contributed by the members is sent to the chairman, Prof. Frank L. Eidmann, of Columbia university and mimeographed copies are distributed to members.

* * *

New Automotive Oil Engine Is Developed

PROGRESS in automotive oil engines abroad is indicated by a new unit of high specific gravity based on a combustion system with unusual features. This engine has been developed to the commercial stage by F. Oberhaensli & Cie and now is being used for powering Vomag motor trucks of the Voltlaendische Maschinenfabrik in Germany.

Major emphasis has been placed on the combustion system and low maximum pressures are claimed to make it particularly suitable for engine designs in which reduction of weight is a primary consideration. Dr. Kurt Neumann, professor at Hanover Technical college and leading authority on diesel technology, is conducting research to determine the scientific basis of the combustion method. Road tests conducted during the past few weeks have included operation of the vehicle on heavy grades with platform loads exceeding 5½ tons. Results are said to have confirmed Dr. Neumann's technical estimate.

* * *

Mechanical Refrigerators Show Annual Gains

PROGRESS in one of the newer industries, the mechanical refrigerator, is advancing steadily, making gains in production each succeeding year. At present it appears that there are 42 separate concerns in the United States engaged in building almost as many different models of mechanically operated refrigerators. So steady has been the growth in the number of these units produced annually that the best trade authorities extimate that within two years there will be 2,000,000 such domestic ice plants in operation in this country.

* * *

Fatigue of Metals Abstracts Are Published

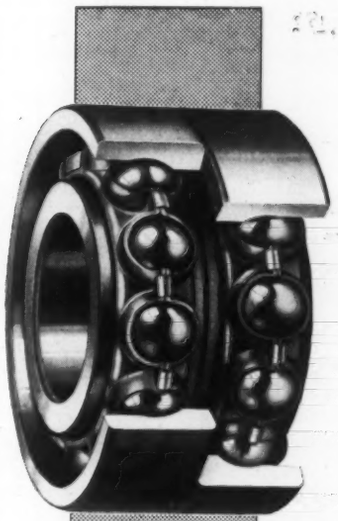
FATIGUE of metals in all its divisions as covered by the technical press during the year July 1, 1929, to June 30, 1930, is reviewed in a series of abstracts recently prepared by the American Society for Testing Materials. The abstracts have been prepared by the research committee on fatigue of metals to be of use to those interested in materials both by giving a concise summary of some of the most recent work in this particular field and in giving references.

* * *

Electrical Engineers Discuss Electron Tubes

ELECTRON tubes in industry and automatic regulating devices, two divisions which have shown usual development during the past year, occupied an important place in the annual meeting of the American Institute of Electrical Engineers held in the Engineering Societies building, New York, late in January. The enormous range of uses for which the electron tube is applicable daily is growing larger, while automatic regulation of voltage, power factor, speed, power output or input has come into wide use.

A form of synchronous motor has been devised which has starting characteristics resembling those of the slip-ring induction motor, attained through the use of a special form of damper winding in which the bars are of low resistance and instead of being joined to end rings to form the usual cage construction are phase-connected and brought out through slip rings to an external starting resistor.



MAXIMUM SPINDLE RIGIDITY
with
Gurney Duplex Ball Bearings

° ° ° ° ° ° °

Under Heaviest PRE-LOAD DUPLEX *Equipped* SPINDLES *Are* FREE-RUNNING *and* COOL

Higher speeds and deeper cuts — the dampening of vibration and elimination of chatter to produce a smoother finish — these are modern machine tool demands that call for the unsurpassed spindle rigidity to be had with Gurney Duplex Ball Bearings.

Spindles — Duplex equipped — run smooth and cool — a definite indication that tremendous pre-loading for maximum rigidity does not increase friction. Even under heaviest pre-load (greater than can be successfully applied to any other bearing) the Duplex equipped spindle can easily be turned by hand.

In the Gurney Duplex Ball Bearing, engineers find a spindle support bearing which they can install and forget—that will maintain uniform working tolerances during the entire life of the machine. GURNEY BALL BEARING DIVISION, Marlin - Rockwell Corporation, Jamestown, N. Y.

THIS METHOD OF PRE-LOADING GETS MAXIMUM RIGIDITY

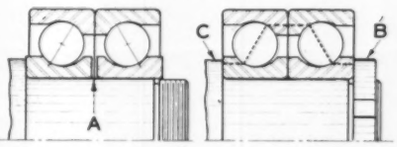
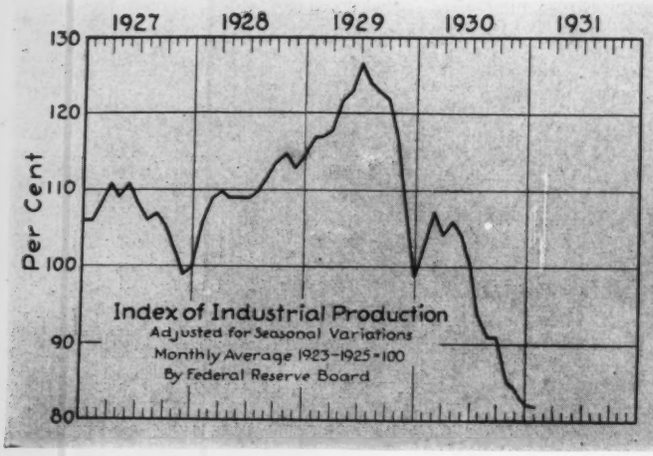
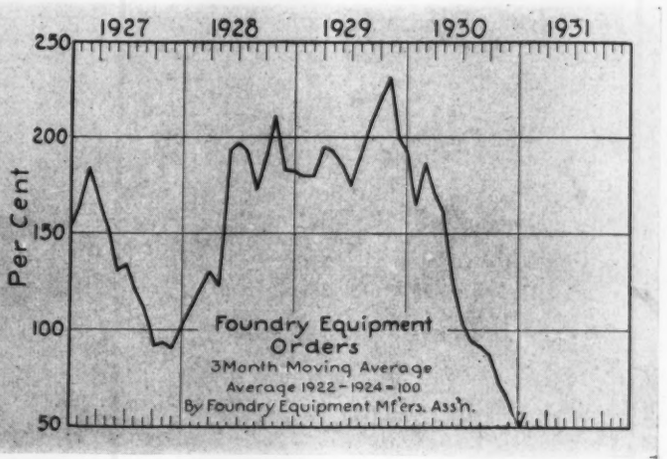


Figure 1 shows the Duplex Ball Bearing assembled on the shaft ready to be pre-loaded. The clearance "A" between the inner rings of this two-piece bearing is ground at the Gurney factory and controls the amount of pre-load that can be applied.

Figure 2 shows the Duplex under pre-load. The shaft nut "B" squeezes the bearing together taking up the clearance "A" and with it all radial and axial looseness. The dotted line shows how the pre-load pressure is transmitted from the nut "B" to shaft shoulder "C" and how the heavy shoulders of the outer rings give this bearing its enormous thrust capactiy.

GURNEY BALL BEARINGS



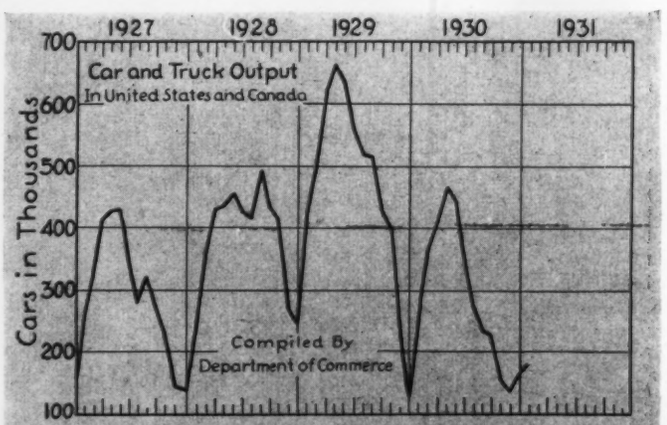


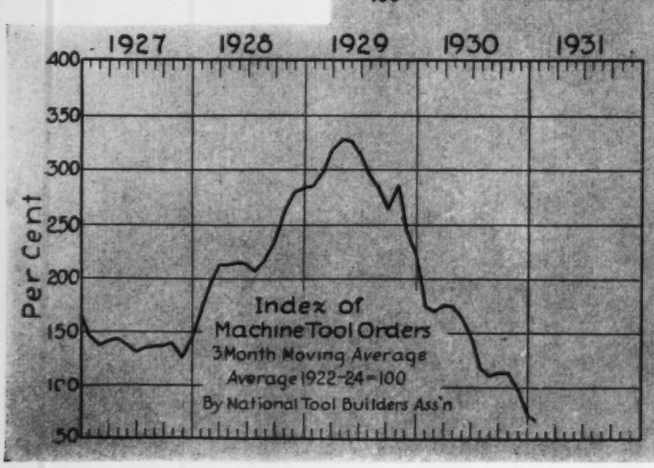
How Is Business?

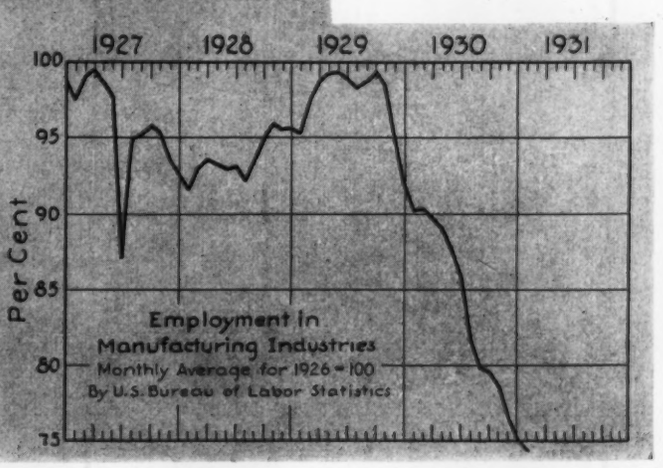
UNDER the influence of the automotive industry and the general bullish tendency apparent through the country, business definitely committed itself to a certain, although gradual, increase throughout February.

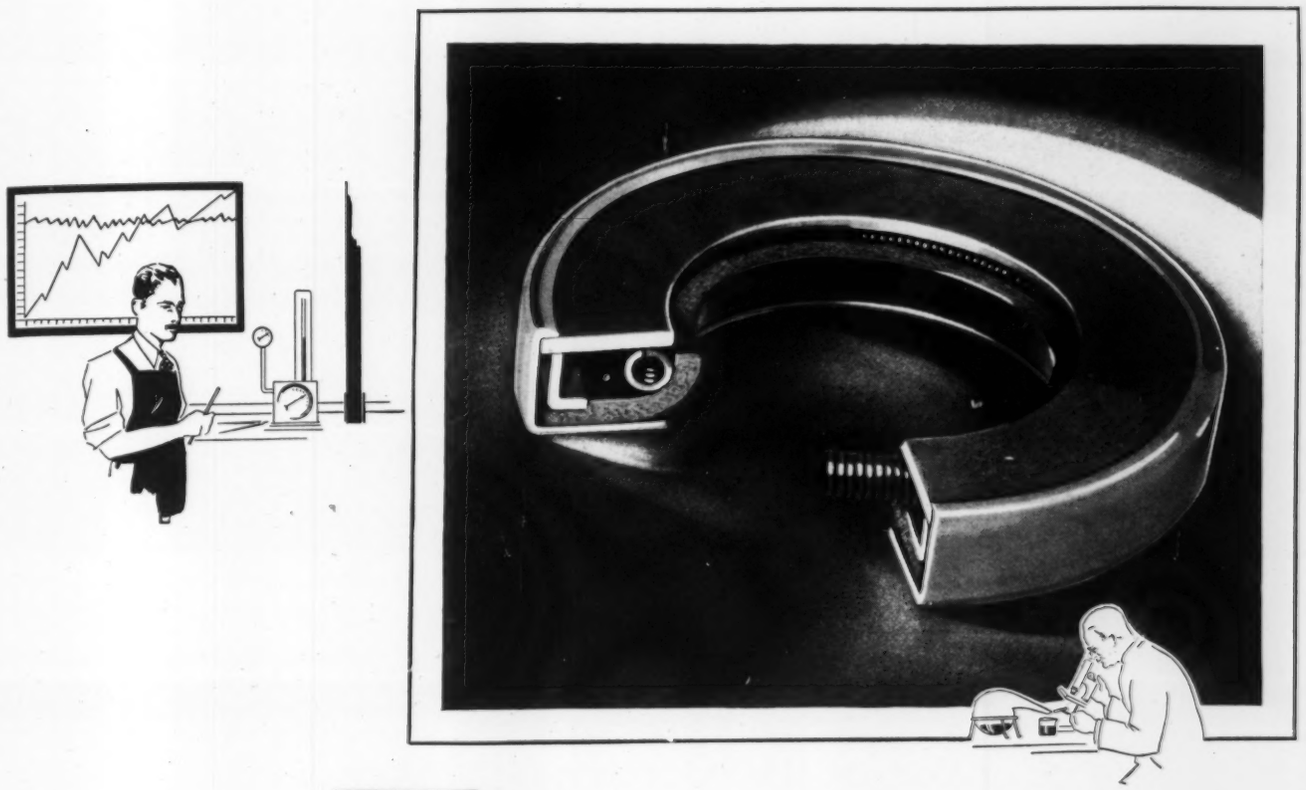
The production of cars turned upwards sharply, although the advances made were not up to the usual seasonal changes, and brought with it a noticeable increase in employment in the lower Michigan district. Employment as a whole declined, due principally to a decrease in the machine tool centers of New England, and despite the fact that orders for machine tools have increased. The design of new parts, evolution of improved production methods, and redesign of parts to provide more economical production and a consequent reduction in price are the only boom markets throughout the country.

Continuing their efforts conceived soon after the beginning of the depression, designers have been putting forth unusual efforts to improve their products. This development carries the manufacturer to the point where he is equipped to meet the rising tide of business with new products, improved labor saving machinery and decreased costs. The definite upturn of the stock market has been interpreted by many as being the leader of a general revival of business. Business has definitely picked up, even though it still is behind the seasonal advances usually recorded during the first quarter of the year.







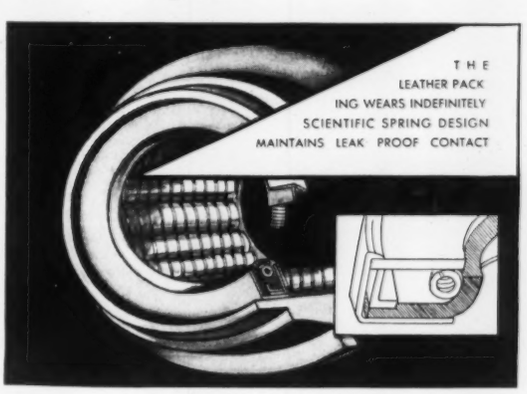


THESE EXPERIMENTS WERE MADE FOR YOU

BEFORE the highly perfected PERFECT OIL RETAINER was put into production every conceivable type of leather seal was made up experimentally—combining the very best of leathers with all methods of spring construction. These were strenuously checked on the exacting testing equipment of our research laboratories. That seal which held the highest rating of performance is the PERFECT OIL RETAINER.

These experiments were made for you. Profit by them! The PERFECT OIL RETAINER is the most efficient, economical oil and grease retainer obtainable today.

Delivered as a compact, self-contained unit, this seal is installed by a simple press fitting operation. Our engineers will gladly cooperate with you without obligation.



Perfect OIL RETAINERS

The
CHICAGO RAWHIDE MANUFACTURING
Company
1304 ELSTON AVE., CHICAGO
Branches: NEW YORK, DETROIT, CLEVELAND, PHILADELPHIA, PITTSBURGH

IF MADE OF LEATHER FOR MECHANICAL PURPOSES WE MAKE IT

Blue Bird Embodies Unique Design Features

(*Concluded from Page* 36)

steering wheel with three spokes consisting of laminated steel springs. Axial rotation is positive due to the width of the laminations lying in the plane of the wheel. Flexibility is provided in other planes, increasing driving comfort. Three spokes are used in order to provide better visibility of the instrument board. At the base of the column, a bevel gear imparts rotation to a transverse horizontal shaft, at each end of which is located the steering mechanism.

The body design is the result of extensive research with a model in wind-tunnel tests. Since resistance goes up as the square of the speed, reduction of air resistance is virtually as important in body design as is the planning of the chassis and power plant. The original design was altered gradually until satisfactory results were obtained. One of the major changes was in the size of the directional fin at the rear which is probably the most conspicuous part of the Blue Bird. Being located behind the rear axle, it imparts stability to the car and assists in correcting any skid or surge from the straight path due to the resultant air pressure. The fin is about 6 feet long and its top edge is 5 feet from the ground. The fin covering, as well as the body itself, is made of aluminum panels mounted over a frame work. An especially rigid steel tubular frame supports it, being similar in design to the welded type of airplane fuselage construction. The fin is offset toward the right in order to line up with the driver and the windshield.

The body is made up of two streamline forms, one rising in front and gradually sweeping down to the rear. The other consists of a rise over the vertical cylinder bank which continues into the sloping windshield with triangular sides. Next comes the driver's head, the projection of which is continued by a rise in the body that blends into the vertical fin. The forward end of this last rise is padded as a head rest. The frontal area of the car is 14.5 square feet.

Fairings Provided for Each Wheel

A circular body in itself is far from a true streamline. The tapering tail is missing. Hence we find a fairing behind each wheel, while the rear wheels have a front one besides which is supported by a streamline fairing covering the rear springs. Due to the long reach required for a similar one for the front wheels, it was omitted. Since the course is a straightaway, the composite wheel and fairing form is effective on the front wheels. These fairings come within 1½-inch of the tires and are made of heavy gage aluminum sheet. However, a light gage is used to form a circular segment 5 inches from the edge. This is a safety measure so that in case of a tire becoming deflated, it will crumple up the light construction and prevent fouling which might result in a disastrous overturn.

A clever idea consists in a combined sight and engine tachometer at the highest, forward part of the body. This is of course immediately in line with the driver and in looking forward aids the sense of direction. Flags were placed along the course to help the driver. Naturally he could not take his eye off the course. Enclosed in the faired-off sight projection was a second tachometer, the other being on the instrument board. It had three calibrations—3500, 3800 and 4000 revolutions per minute—visible from the seat. In this way, the driver knew exactly what he was doing in speed without any risk. This dual purpose idea could find numerous applications in industry and research.

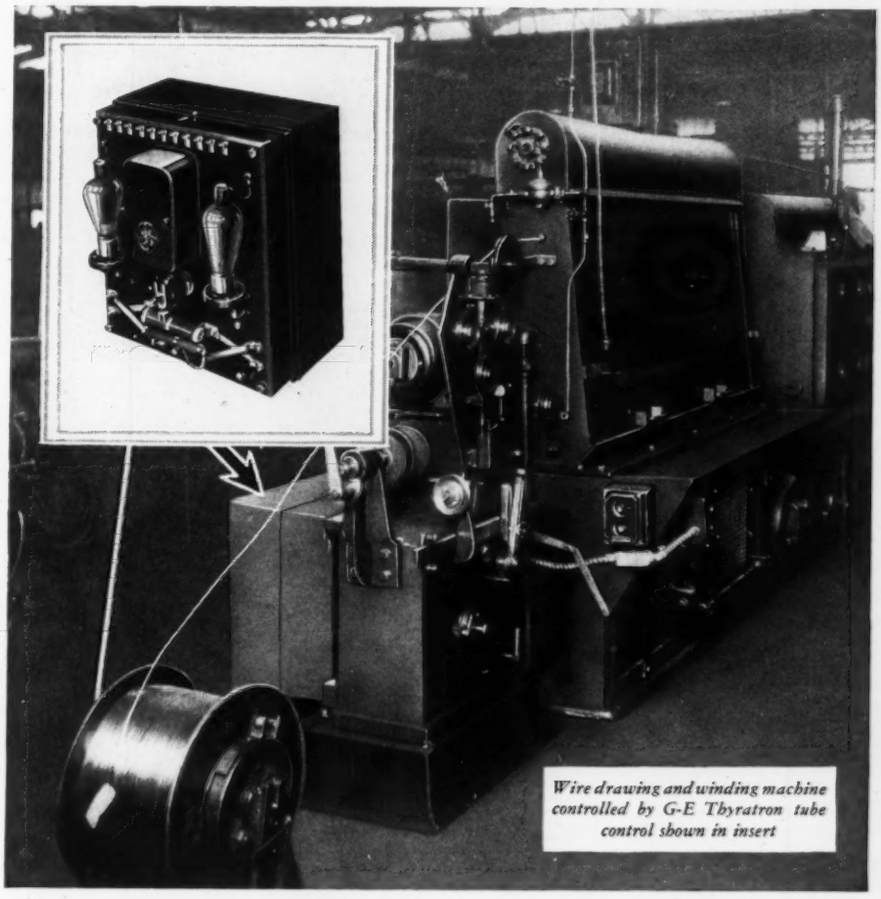
Special Screw Jack Is Necessary

As it is difficult to try to raise a car that is completely enclosed in fairings, a screw jack of the most elementary design was incorporated. A threaded boss was provided at the four corners of the frame. A threaded shaft with a loose cross bar and base plate to prevent the shaft digging into the sand complete the equipment. Since the springs are exceptionally stiff in order to withstand impacts at high speed and therefore flex very little, this scheme is feasible. In an ordinary car with supple springs it would not be practical.

After having described the car, a few words about Sir Malcolm would not be amiss. Most modest and unassuming, a gentleman to the core, he broke another record beside that for which he has been knighted. Just two weeks after he set foot on American soil, during which time the car was transported to Florida, assembled, tuned-up and tried, he piloted his Blue Bird over a rough beach that was covered with shimmering pools of water and in spite of poor visibility at a speed in excess of four miles a minute, the fastest man has ever travelled on land. The serious workmanlike manner in which he so expediously accomplished this feat is a remarkable accomplishment in itself. Since it was impossible to try out such a car at home, its performance was really an unknown quantity, until the day of the actual attempt. The anxious anticipation that labored in Sir Malcolm's heart was gloriously consummated.

Permission of *The Autocar,* London, to reproduce the line cuts forming a part of the illustrations in this article is acknowledged with thanks.

VACUUM TUBES FOR INDUSTRY, SCIENCE, AND ART



Wire drawing and winding machine controlled by G-E Thyratron tube control shown in insert

MOTOR CONTROL FROM A VACUUM TUBE

OUT of the Research Laboratories of General Electric has come the Thyratron—vacuum tube of myriad applications.

Designers of General Electric control have taken this remarkable tube and have combined it with suitable apparatus into a compact, commercial control unit for varying the speed of small industrial motors. Such control is continuous, stepless, and highly efficient in its precise response to delicate forces.

To the process of wire drawing and winding, for example, the Thyratron has brought absolutely accurate control of tension between dies and reel, greater safety, and smooth operation. For the reeling of cable, also, this control unit offers advantages which cannot be overlooked.

Scattered throughout industry there are numerous other applications to which this unit can bring a new conception of accuracy, safety, and dependability.

Why not ask the nearest G-E office to tell you more about the time and money-saving applications of G-E vacuum tubes?

301-60

GENERAL ELECTRIC

SALES AND ENGINEERING SERVICE IN PRINCIPAL CITIES

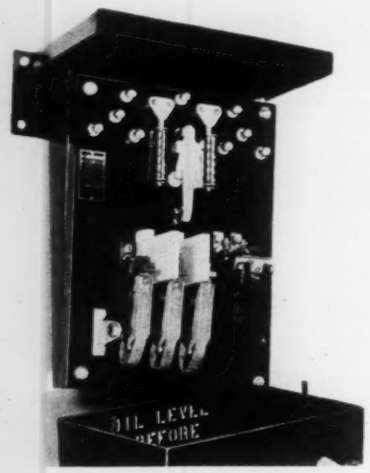
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

New Starter Provides Protection

ACROSS-the-line full-voltage starting, together with overload and low-voltage protection is provided by an oil-immersed starter recently brought out by Monitor Controller Co., Baltimore. This starter, shown in the accompanying illustration, consists of a standard magnetic contactor mounted on a panel with a thermal relay, the assembly being enclosed in an oil-tight box. The oil level is regulated so as to completely immerse the contactor and the contacts of the relay, but leaving the thermal elements above the oil line.

This starter gives positive protection to polyphase and single-phase motors both while starting and while running. It permits full-voltage full-current and full-torque starting and yet

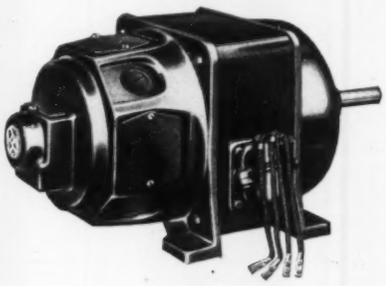


Oil-immersed control unit consists of standard magnetic contactor mounted on a panel with a thermal relay and is enclosed in an oil-tight box

protects the motor from harmful operating overload. In addition to the usual overload protections, it will disconnect the motor in case the voltage drops below normal to an excessive degree. The starter also will prevent damage to polyphase motors from running single-phase, in case one of the phases goes dead, which otherwise would overload one of the phases.

Introduces New Line of Motors

IDENTICAL mounting dimensions on repulsion induction single phase, polyphase, and direct current types is one of the innovations on the new line of box frame motors recently introduced by the Robbins & Myers Sales Inc., Springfield, O. The motors, one of which is shown in the accompanying illustration, have semienclosed end heads and are of compact, powerful construction. An improved wool yarn

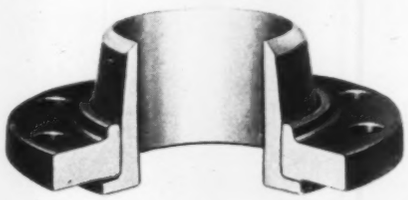


Box frame motor has semienclosed end head and improved wool yarn bearing lubrication system

bearing lubrication system is standard, but ball bearing motors of identical types are built on special order. The standard types are stocked for shipment in sizes from ½ to 3 horsepower.

Swivel Flange Has Flexibility

NEW type of flanged joint just developed is for use in connection with welded pipe lines where such a joint is required for the insertion of valves and fittings for the taking off of outlets. Known as the "Merco" swivel flange, it is a



Swivel flange with section cut away to show construction

unique device possessing fully the inherent flexibility of the Vanstone type of flange, plus the strength of an ordinary butt welded flange, according to the manufacturers, Merco Nordstrom Valve Co., San Francisco.

It consists of a drop forged steel flange, fitted to a drop forge tapered nipple on which the flange may be rotated, permitting alignment of bolts,

POUGHKEEPSIE PLANT · THE FEDERAL BEARINGS CO., INC.

. . . . THE FINEST BALL BEARINGS ARE MADE IN THIS GREAT PLANT. . . .

QUALITY in materials and precision in manufacture . . . . These are the characteristics which distinguish Federal Ball Bearings. The interlocking ball retainer is an *exclusive* feature which adds much to the efficiency of «Federals.» For many years, the manufacturers of America's leading cars have selected these bearings because of splendid performance and absolute dependability.

THE FEDERAL BEARING COMPANY, INC.
Poughkeepsie, N. Y.

associated with

The Schatz Manufacturing Company, Poughkeepsie, N. Y.,
Manufacturers of Commercial Annular Ball Bearings.

Detroit Sales Office: 917 *Book Bldg.* . . . *Chicago Sales Office:* 120 *N. Peoria St.*

FEDERAL

BALL BEARINGS

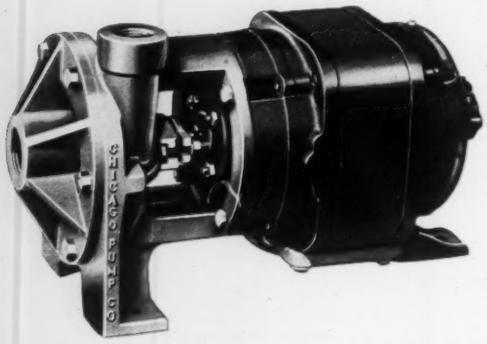
etc. The tapered nipple is forged from a solid steel billet and the finished product incorporates a thickness much greater than pipe at the base of the nipple where highest stress occurs. Being formed completely at the proper forging temperature, possibility of a fracture of the metal is minimized.

The manufacturers state that by forging from a solid billet sufficient heat is stored up in the steel to permit operation being finished at the correct forging temperature. Production soon will make available sizes from 1½ inches to 10 inches, and specifications are to meet the American standards in strength requirements.

Pump Requires Minimum Space

STRAIN occasioned by uneven mounting conditions is eliminated in a line of horizontal centrifugal pumps recently brought out by Chicago Pump Co., Chicago. Three-point suspension, enabling the pump to rest evenly on any surface is used. The pumps, one of which is shown in the accompanying illustration, are compact, close-coupled, use minimum space and operate quietly. They are applicable to hot and cold water circulation, brine circulation, water supply and booster service, and other factory and industrial services.

Two of the three feet are placed under the pump to support weight of pipe, thereby relieving the motor shaft and motor frame of any excessive stress or strain. The pumps are available without a water seal, with an inside connected water seal and with an outside connected water seal. Where there is a positive pressure on the suction a water seal is not necessary.



Horizontal centrifugal pump which is compact and close coupled

Set Screw Has Locking Power

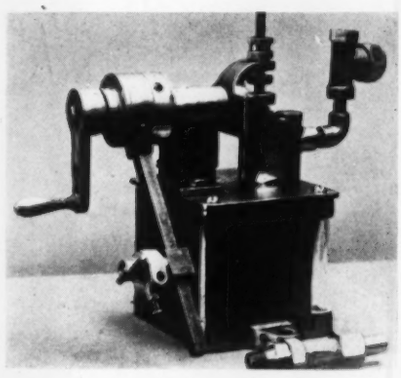
ASSURANCE of positive locking, without extra operations, by the offsetting of the end of the screw is provided by the Shakeproof Lock Washer Co., Chicago, in the design of a new set screw. In the inset view in the accompanying illustration the offset that insures positive locking is shown.

When inserted, the sharp edges of the screw bite into the work and extert resistance to any backward movement successfully overcoming the tendency of vibration, shaking or bumping to loosen it. The locking power can be varied to suit particular requirements by increasing or decreasing the amount of offset. Where it is necessary to have a set screw that can be removed easily, the degree of offset is reduced, and where the product is exposed to intense vibration, the offset can be increased to insure absolute efficiency.

Set screw which employs offset to provide locking power. Amount of offset can be increased or decreased to meet requirements

Develops New Lubricator Drive

DESIGN of a new driving mechanism in connection with its line of lubricators, which now may be obtained either with this new mechanism or with the ratchet type of drive, recently was announced by Hills-McCanna Co., Chicago. The lubricator shown in the accompanying illustration is equipped with the new mechanism. This comprises a right member which is attached to the standard for the purpose of holding the crankshaft when on the back stroke, and a left hand member which is attached to the driving rod operating the crankshaft on the forward stroke. In operation



Cam-type lubricator control provides increased speed of oil delivery and is interchangeable with ratchet drive

The Simplest Way to Solve Intricate Design Problems

NOT only transmission problems—but often the problems of arranging the units of the machine are easily solved . . . when you turn to Diamond Roller Chain Drives.

With this transmission, you may place units of your machine where they best fit—and rely on the flexibility of the Diamond Drive to "hook" them up into an efficient system. Diamond Roller Chain is equally efficient as the primary power drive, as the transmission between multiple centers, or as an intra-machine conveyor. It is light in weight, compact, strong . . . and economical.

It possesses eight points of superior application . . . of vital interest to the machine designer. These eight points are fully described and illustrated in booklet 104B "*Simplifying and Improving Machine Design.*" Send for a copy.

DIAMOND CHAIN & MFG. CO.
435 Kentucky Avenue
Indianapolis - - - Indiana
Offices and Agents in Principal Cities

DIAMOND ◇ DRIVES
for Every Industrial Need

This Diamond on every link identifies Diamond Chain

NO LET-DOWN IN SPEED AFTER YEARS OF USE

DIAMOND CHAIN & MFG. CO.
435 Kentucky Avenue, Indianapolis, Indiana
Gentlemen: Please send me a copy of Booklet 104B, "*Simplifying and Improving Machine Design.*"

*Name*_____

*Firm*_____

*Address*_____

*City*_____ *State*_____

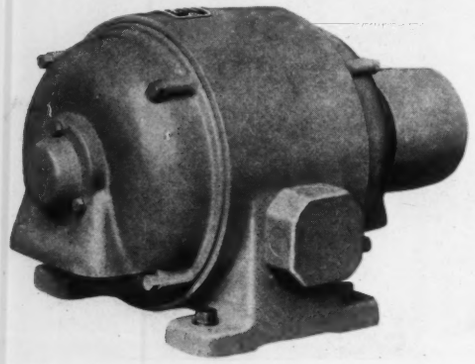
(A-4162)

spring-held rollers in the housing bear against and work with the crankshaft.

The drive permits attachment to high-speed driving arms in any position within the arc of a complete circle. It is said to give the lubricator greater speed in oil delivery when and where needed. Parts are of hardened steel and are packed in grease to insure trouble-free operation. The device is interchangeable with the ratchet drives. Another new feature embodied in these new lubricators is the charging arm or crank shaft used to flush out cylinders when starting up or to increase flow when the lubricator is in operation.

Rotor Operation Features Motor

NOISELESS operation provided by the elimination of the noise of bearings, end thrust, and back and forth lateral pounding, is the principal feature of the new herringbone rotors now being used in motors manufactured by Sterling Electric Motors Inc., Los Angeles. The



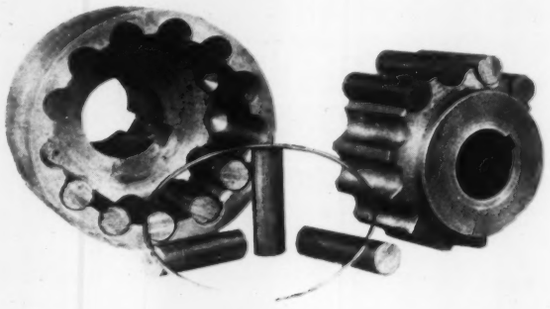
Motor in which new herringbone rotor provides noiseless operation

rotor improves pull-out efficiency and power factor, reduces exciting current, heating, eddy current and iron losses, and does away with circulating currents detrimental to the characteristics of the motor.

Operation of the rotor is similar to the pointed bow of a ship sliding through the water, or to the operation of the commonly used herringbone gears. The elimination of end thrust also reduces considerably the resulting wear on bearings. Mica and asbestos are used to protect the windings of the motor, while lead connections are enclosed in specially treated telescoped tubes, no friction tape being used.

Coupling Is Simple in Design

SIMPLICITY, minimum diameter and light weight as well as easy assembly and disconnection are some of the principal features of the flexible coupling recently placed on the market by Dodge Mfg. Co. Ltd., Toronto, Ont. It operates equally well in either direction, is specially adapted to equipment with frequent reversals, has unusual flexibility, is shock ab-



Disassembled parts of new flexible coupling

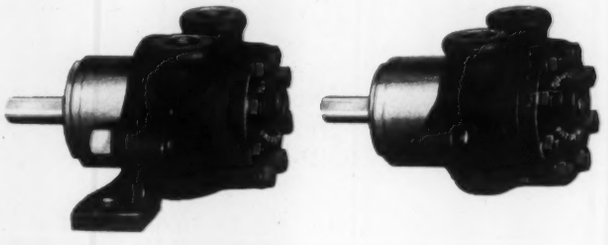
sorbing and an electrical insulator.

Possibly the most outstanding characteristic is the extreme simplicity of design and small overall dimensions. The former has in the case of this coupling resulted in minimum of wearing parts and has eliminated the problem of lubrication at any speed under any conditions.

Having only two metals parts, the unit is connected by a series of flexible and insulating pins which transmit the peripheral power from one part to the other. There is no bending or transverse shear on the pins, the shearing force being evenly distributed over their total length. An appropriate amount of clearance between the two metal parts enables the coupling to take up errors in alignment.

Pump Seal Eliminates Packing

A NEW contribution to the solution of liquid movement and hydraulic power transmission problems is introduced by the Tuthill



Model L pump with and without foot mounting

Pump Co., Chicago, with the announcement of the model L pump series. The new unit is of the internal gear, positive delivery type.

Six sizes are available ranging in capacity

Analyze your modern bearing problems in the light of Timken abilities

Whether you are designing new machinery or bringing existing designs up to date, bearing selection is one of your most important problems.

This involves the consideration of many different factors of speed and load, but you will find in Timken Bearings, new and exclusive opportunities to improve production, reduce operating and maintenance costs and lengthen machine life through the following fundamental mechanical characteristics.

RADIAL LOADS AND THRUST LOADS Because of their tapered construction, Timken Bearings carry without compromise radial loads, thrust loads, or both loads in any combination, making possible more simple, compact, effective, wear-proof, and rigid mountings.

GREATER LOAD AREA Timkens are line contact bearings. Size for size, they have a greater capacity because the loads are distributed on the entire length of the rolls, cup and cone, instead of being concentrated on a very small area.

POSITIVELY ALIGNED ROLLS The design of the Timken Bearing provides for full contact along the entire length of the roll, cone and cup. The rolls are positively aligned to the axis of the cone and cup, thus allowing the bearing to function continuously at its full extra capacity.

WEAR-PROOF The longer life of Timken Bearings and their greater resistance to wear is made possible because the loads are distributed over the entire length of the rolls, cone and cup; because of the fact that radial, thrust and combination loads are provided for; because of the special analysis Timken-made steel; because all the contact parts are case hardened to give them a glass-hard outer surface with a tough elastic inner core; and because each part is made to extremely accurate dimensions. Even after hundreds of millions of revolutions, wear in a Timken Bearing is so slight as to be practically imperceptible even when measured by delicate instruments.

A PRECISION PRODUCT So accurately and precisely made is the Timken Bearing that it has become the universal standard on machine tool spindles, where a few years ago such accuracy was thought beyond attainment.

FRICTIONLESS The Timken Bearing is practically 100% frictionless: The higher load capacity and greater wear resistance of tapered line contact are thus obtained at an insignificant power loss almost impossible to calculate.

TAKE-UP IN ASSEMBLY The take-up feature in the Timken Bearing is a great advantage in assembly. Manufacturers find this to be of tremendous benefit as it allows for minor machine irregularities, the locating of gears, etc. Last but not least, since slight wear is inevitable in any machine that revolves—(regardless of any statements to the contrary)—the Timken Bearing is designed for this take-up without affecting the proper operation of the bearing.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

TIMKEN *Tapered Roller* BEARINGS

from 3 to 180 gallons per hour. Speeds up to 3600 revolutions per minute are possible in the smaller pumps and up to 1800 revolutions per minute in the larger sizes. Pressures up to 200 pounds per square inch can be developed in the larger units.

Construction features include mechanical seal which eliminates packing and prevents the possibility of overheated motors due to improper packing adjustments; mounting flexibility through a new standard design, primarily arranged for end mounting with optional bracket for users desiring foot type of mounting; upright ports to maintain "prime;" ground housing bore to maintain smaller clearances and, therefore, higher pressures. Model L pumps are designed for oil burning installations of various sizes, for hydraulic applications, etc.

Pumps Provide Quiet Operation

HIGH volumetric efficiency, 500 pounds per square inch continuous working pressure and 1000 pounds for press work, high mechanical efficiency, and long life with quiet operation are characteristics of V-Type rotary pumps which are being placed on the market by Vickers Inc., Detroit.

Two sizes now are available; capacities being 15 and 30 gallons per minute at 1000 revolutions per minute. These pumps are for use in

Small installation space is required by this line of V-type rotary pumps

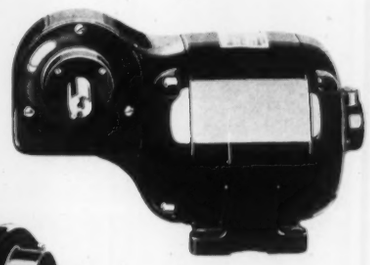
all machinery where hydraulic feeds and controls are desired. All working parts readily can be removed from one end without disturbing motor connection or pump piping. Harmonic curves in the ring at the ports give a balanced pressure on both sides of the vanes, thus increasing mechanical efficiency and eliminating side thrust and consequent wear on bearings. There is no appreciable drop in volumetric efficiency and delivery at higher pressures and overall mechanical efficiency practically is constant from 500 to 1000 pounds pressure.

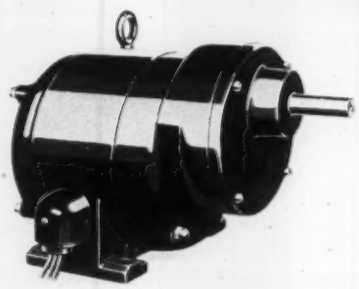
All parts are interchangeable and larger capacity can be secured by changing the internal parts. Small installation space is required in proportion to capacity and weight of the pump only is 32 pounds. Rotor, ring and vanes are alloy steel, hardened and ground, while the port bushing and flange bushing are of hydraulic bronze. The body is of special high-test nickel cast iron. Packing is not under oil pressure and the body is completely drained to eliminate oil leakage.

Overcome Mounting Difficulties

EQUIPPED with antifriction bearings throughout with precision ball bearings on the motor shaft and selected roller bearings on the countershaft, a geared head motor of the parallel shaft type recently was announced by Master Electric Co., Dayton, O. This design permits of mounting in any position without change in construction. Steel gears of the continuous tooth herringbone type are standard and where extreme quietness is essential, a composition gear can be supplied at slight additional cost.

New geared head motors may be equipped for right-angle drive as shown at the right





Unique oil seal arrangements give positive protection against leakage

Through the use of a unique oil seal arrangement, positive assurance against leakage is obtained. Gear housing can be arranged so that shaft projects in any one of four different positions, either at the top or bottom on the vertical center line, or to the right or left on the horizontal center line.

Sizes range from 1/30 to 5 horsepower single phase, direct current; 1/30 to 20 horsepower, polyphase with interchangeable frames for the same horsepower and speed in different types of current. The unit is available in multiples of .25 for any ratio between a maximum reduction of 6:1 and a maximum acceleration of 2.5:1 of standard motor speed.

Concurrently, announcement also was made of a geared head motor of the right angle shaft type. It is built in sizes from 1/30 to 5 horsepower, single phase and direct current; 1/30 to 10 horsepower, polyphase, with interchangeable frames for the same horsepower and speed in different types of current. Standard ratios on

A CORK GASKET

BETWEEN THE GLASS CASE AND THE METAL BASE

Seals this GE METER

Keeps out dust and moisture, cushions against breakage, and won't deteriorate with age . . .

USED not only in the G-E watthour meter, but also in other electric, gas, and liquid meters, recording devices and instruments of various types, Armstrong's Cork Gaskets make tight, shock absorbing seals. If you need a resilient material for use between metal and glass or porcelain, consider Armstrong's Cork.

Its non-fibrous, cellular structure makes cork resilient and non-absorbent. It fills every uneven spot between adjoining surfaces—acts both as a seal and a cushion. Breakage in assembly is minimized, thus speeding up production. Even under light compression cork effectively seals out dust and moisture.

Armstrong's Cork does not harden, shrink, or become brittle. It will not deteriorate with age. No other material, natural or synthetic, combines to the same extent the properties of cork . . . resilience, compressibility, resistance to liquid and air penetration, low thermal conductivity, chemical inertness, stability, light weight, high frictional efficiency, and low cost.

Engineers and designers of machinery are making cork solve problems not only of sealing and cushioning, but also of sound deadening, insulation, friction (both driving and braking), and other troublesome questions.

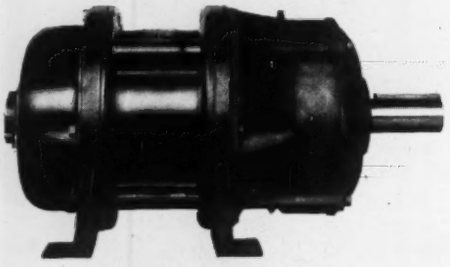
For more information write for the free book, "Industrial Applications of Cork," which describes the properties and industrial uses of cork. Or, better yet, submit your problems to our engineers. Armstrong's Cork can be formed to your specifications. Address Industrial Service Section, Armstrong Cork Co., 918 Arch St., Lancaster, Penna.

Armstrong's (A) Product

Armstrong's CORK

MADE TO YOUR SPECIFICATIONS

Speed Reduction Simplified



Front Gear Motors with WATSON-FLAGG Built in Helical Gear Reduction Units

FEATURES

All gear reduction with helical gears

Quiet in operation

Highest efficiency—Full anti-friction bearings

Dustproof—Oil tight—Internal oiling system for bearings and gears

Rugged—Built to transmit any load motor will start—Overhung loads permissible on shaft extension same as standard motor

Easy to install—Saves labor and space

STOCK SIZES

1/6 to 30 H.P. 3600 R.P.M. Down. Standard Gear Ratios 11-2/3:1, 11:1, 10-1/3:1, 9:1, 8:1, 7:1.6:1.5:1.4:1.

Unlimited variety special ratios furnished to order. ***From - 144 to 1.***

Write for Bulletin 3

WATSON-FLAGG MACHINE CO.

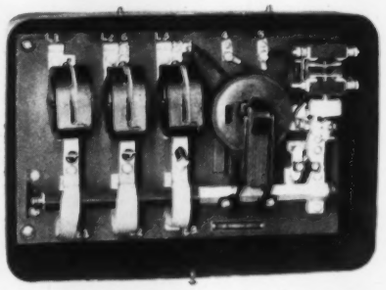
Paterson, N. J.

which prompt delivery is obtainable, range 8:1, 12:1, 18:1, 24:1, 30:1, 36:1, 48:1, 60:1 and 72:1. Practically any ratio between minimum and maximum can be obtained at an increase in price and extended delivery.

It also is equipped with antifriction bearings throughout. Worm gear is manganese bronze of a composition specially developed for this service. Uniformity is maintained by close supervision of analysis and high carbon steel, properly processed, insures long life. Worm gear housing can be arranged so that shaft projects in any one of eight different positions, either at the side of the housing with the housing at the top or bottom on the vertical center line, or to the right or left on the horizontal center line.

Magnetic Switch Has Positive Action

USE on either alternating or direct current circuits is a feature of the CR-2811 magnetic switch recently announced by General Electric Co., Schenectady, N. Y. This unit is provided with a latch which holds the contactor closed. Such a condition is particularly desirable where the hum of a standard magnetic switch must be eliminated.



Interior of magnetic switch which is positive in action

The device consists of a two or three-pole, alternating current contactor with a latching mechanism, mounted on a base and with or without an enclosing case. The contactor is standard except for an extension of the shaft to which the latching mechanism is attached.

In operation, momentarily energizing the main contactor coil closes the contactor which then is latched closed. Momentarily energizing the trip coil trips the latch and opens the contactor. Either a single-pole, double-throw knife switch or a two-button, normally open, momentary contact type of push button may be used for this purpose.

The switch is positive in its action. It is impossible to latch the contactor except in the fully closed position. The construction of the latch and the spring pressure applied to it provide

An Offer of $17,500.00

which you cannot afford to overlook

If all or part of your products are made of iron or steel you can improve them and lower their manufacturing cost by the use of arc welding. Try it—then record the results in a paper and submit it in the Second Lincoln Arc Welding Prize Competition. How well you utilize the advantages of arc welding will determine the amount of prize money you may receive. There are forty-one cash prizes which will be awarded as follows:

FOR FIRST PRIZE PAPER	$7,500.00
FOR SECOND PRIZE PAPER	3,500.00
FOR THIRD PRIZE PAPER	1,500.00
FOR FOURTH PRIZE PAPER	750.00
FOR FIFTH PRIZE PAPER	500.00
FOR SIXTH PRIZE PAPER	250.00
FOR SEVENTH TO FORTY-FIRST PRIZE PAPERS	100.00 each

Write today for full particulars. Address:

THE LINCOLN ELECTRIC COMPANY
P. O. Box 683 · Cleveland, Ohio

Here's that *Super* Bearing Metal You *have been looking for*

"SABECO"

REG. U.S. PAT. OFFICE

EXTRAORDINARILY long life (unapproached by any other bearing metal) under severe service conditions of heat, high speed, low speed, minimum lubrication, acid, pounding, and strain stamps "SABECO" as being truly a high unit pressure Super Bearing Metal. Under light service conditions its life is indefinite.

The chances of success of any new machine design will be materially increased if "SABECO" metal is specified for all bushed bearings—it will stand up where all others fail.

Get the facts on this Super Bearing Metal today — write

Fredericksen Company

841 S. Water Street, Saginaw, Michigan

5-108 General Motors Bldg.
Detroit, Mich.

27 S. Jefferson St.
Chicago, Ill.

Room 418-E.—30 Church St.
New York City

194 Fourth St.
Milwaukee, Wis.

634 Slater Bldg.
Worcester, Mass.

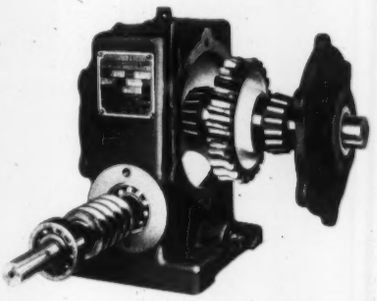
"Know Your Bearings"

"SABECO" METAL
INGOTS, SOLID BARS, CORED BARS, CASTINGS FINISHED TO SPECIFICATIONS
The Certified Bearing Bronze

against a release on account of vibration. The main contacts are silver faced so the switches can remain closed for long periods of time.

Provide Wide Range of Gear Ratios

THOROUGH lubrication is provided in a new line of small speed reducers recently introduced by Horsburgh & Scott Co., Cleveland. The contact surface between worm and gear is always beneath the oil surface, while worm and gear bearings are lubricated directly from this source. These reducers, one of which is shown in the accompanying illustration, are designated as series WB-600 and WB-700 and deliver maximum torques on the gearshaft of 1100 and 2140 inch-pounds, respectively.



Few parts and simple construction feature these small speed reducers

The worm is forged integral with the shaft, providing greater rigidity and concentricity of worm. Threads are hardened to glass hardness, and the top, bottom and sides are accurately ground after hardening. Alignment of worm and gear is provided by radial thrust bearings on the worm shaft and roller bearings on the gear shaft. Distortion from unusual loads is combated in the cast-iron housing by heavy external ribs. The reducers are available in ratios from 4 1/6 to 1 up to 60 to 1, and with worm shaft speeds from 300 to 3000 revolutions per minute.

Gear Unit Provides Four Speeds

COMBINING the advantages of a reduction in speed with multiple speed changes, the Adams Co., Dubuque, Ia., has brought out an efficient and compact unit that is especially useful to the builder of special machinery. Speed changes in the unit, shown in the accompanying illustration, are through sliding gears, controlled by a single lever, with four speeds instantly available. The reducer is well suited to converting belt driven machines over to direct motor drive and can be applied to any piece of equipment requiring speed variations from a constant speed motor.

Smooth-running helical gears provide the in-

YES

. . . there is a difference in

BALL BEARING MOTORS

And there is one sure way to prove it!

Eighteen years ago, Fairbanks-Morse pioneered the ball bearing motor in the firm belief that the improved reliability and lower maintenance cost of this type of motor would inevitably win industry-wide acceptance. The soundness of this belief has been proved.

Today, ball bearing motors are made by practically every motor manufacturer. But this does not mean that all ball bearing motors are alike. The invaluable experience gained in eighteen years of painstaking field research is reflected in the outstanding performance that is responsible for F-M leadership in the ball bearing motor field today.

There is one sure way to prove F-M superiority. Make a comparative inspection of F-M motors and other motors. Check construction details point by point. Study the advantages of F-M *sealed* bearing construction, incorporating the *highest priced ball bearings in the world . . . Then* you will understand why users of F-M ball bearing motors specify them year after year for service that requires maximum dependability and lowest overall operating cost.

It will pay you to get the facts. Let us send literature or let a Fairbanks-Morse engineer discuss F-M motor advantages as they apply to your particular requirements. There is no obligation.

FAIRBANKS, MORSE & CO.

900 S. Wabash Ave., Chicago

32 branches at your service throughout the United States

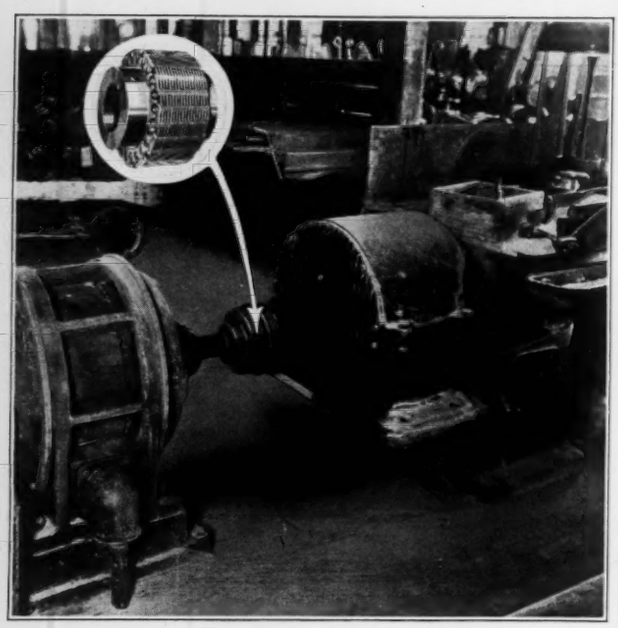
FAIRBANKS-MORSE

MOTORS

POWER, PUMPING AND WEIGHING EQUIPMENT

5283-EA 40.37

MORSE
FLEXIBLE COUPLINGS



Morse Flexible Coupling connecting motor to Morgan Wire Drawing Bench

FLEXIBILITY AT ITS BEST!

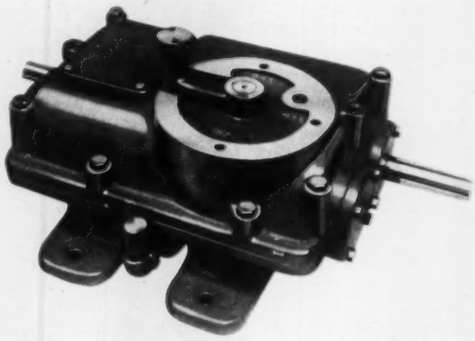
List the important advantages you need in a flexible coupling—you will find them all in the practical, easily installed Morse Flexible Couplings. Flexibility, simplicity, ease of uncoupling, rugged strength, ability to dampen vibration, low first cost, long life—are essential features in coupling operation. You obtain them in Morse Flexible Couplings.

Stock sizes available for immediate delivery. Special sizes for any job. Send for Bulletin No. 37 which gives complete data and prices.

MORSE CHAIN CO. · ITHACA, N. Y.
Branches in Principal Cities
Manufacturers of Morse Silent Chain Drives
Flexible Couplings and Chain Speed Reducers

MORSE SILENT CHAIN DRIVES

itial reduction, while six integral splines give maximum strength and assure easy shifting. The reducers may be obtained with spur, helical or worm gears. Special units such as one



Four speeds available in gear units

with input and output shafts at right angles can be furnished when greater ratios are required.

Pumps Are Built for Severe Service

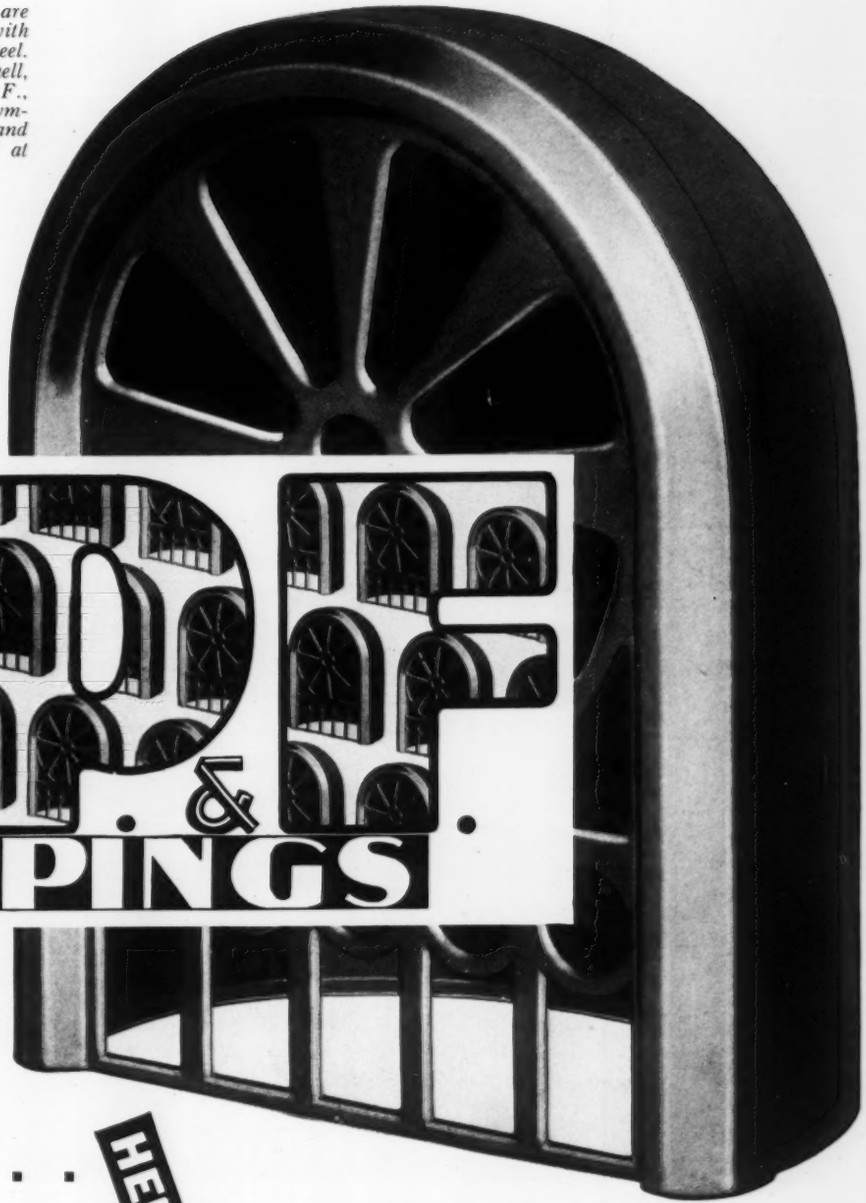
ANNOUNCEMENT recently was made by Allis-Chalmers Mfg. Co., Milwaukee, of an extension to cover three new sizes in its line of SSU centrifugal pumping units of single-shaft, two-bearing design, which now includes ratings from 30 to 500 gallons per minute for heads under 100 feet. Recent adoption of total enclosure of motor housings on the pump end of these units and the use of totally enclosed fan-cooled motors, if necessary, permits their use for severe service conditions.

Some applications of SSU pumps are for: Water supply; circulation of water, oil or brine for heating or cooling systems; for transfer of many liquids; air conditioning; bottle washing and other washing machinery; drainage systems; dairies, or ice-cream plants; house service, auxiliary service for power, etc.

Tungsten Is Available in All Forms

PURE tungsten metal in all commercial forms for general purposes has been made available by Fansteel Products Co. Inc., North Chicago, Ill. The metal has been sold by the company previously only in the form of finished electrical contact points, but it is now obtainable in bars, sheets, wire and powder. Pure tungsten has the highest melting point and lowest vapor pressure of all metals, and it also retains rigidity at higher temperatures. Unusual purity and workability are characteristic of the material. A tough, fibrous structure is obtained in the metal by careful working at accurately controlled temperatures.

Decorative designs are easily produced with drawn or pressed steel. This loud speaker shell, produced by G. P. & F., is light in weight, symmetrical in design and beautifully finished at low cost.



G. P. & F. STAMPINGS

THE MEANS TO LOWER COSTS . . . . .

HERE'S THE WAY

Reproducing parts in exact duplicate, speedily, with greater strength, less weight, less material used . . . requiring little or no machining or finishing . . . that is the way to lower costs, the way G. P. & F. takes you.

Out of 50 years' experience, G. P. & F. has drawn the speediest methods of arriving at the result you want . . . short cuts, efficiencies that no firm with less experience could think of. These savings loom large in your cost sheets.

In addition to this unduplicable experience, G. P. & F. possesses the facilities of a 19-acre plant which assure you finished stampings how, when and where you want them.

A blueprint or sample will bring you quotations. The coupon will bring you the G. P. & F. book *"In Harmony With Modern Progress."* Both without cost or obligation.

GEUDER, PAESCHKE & FREY CO.

Sales Representatives in Principal Cities in All Parts of the Country

1417 W. St. Paul Ave., Milwaukee, Wis.

364 W. Ohio Street, Chicago, Ill.

GEUDER, PAESCHKE & FREY CO.
1417 W. St. Paul Avenue, Milwaukee, Wis.
364 W. Ohio Street, Chicago, Ill.

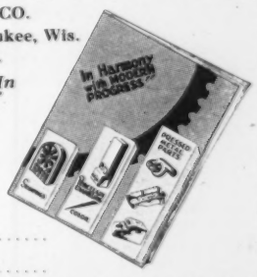
Please send your new booklet *"In Harmony With Modern Progress"* to the address below . . . without charge or obligation.

Name .....

Company Name .....

Address .....

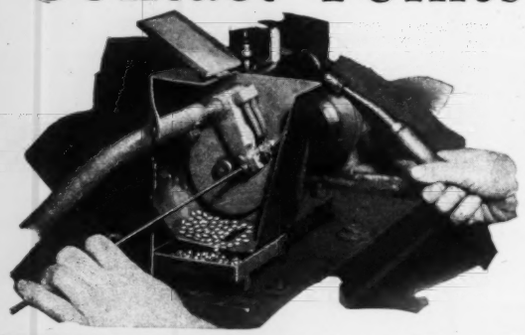
City ..... *State* .....



RARE METALS AND ALLOYS

TANTALUM · TUNGSTEN · MOLYBDENUM · CAESIUM · RUBIDIUM

FANSTEEL
for
Contact Points



"END GRAIN" METAL
feature of
Fansteel Contacts

THIS superior process of making contact points was originated by Fansteel. Instead of the discs being punched from sheets, as is the ordinary method, they are smoothly *sawed* from rods of 99.95% pure Tungsten or Molybdenum under the Fansteel process, making discs *with end grain metal* as a contact surface. Contact Points made of *end grain* metal have a hard, smooth, uniform surface that resists heat and wear, and does not readily stick, pit or flake off. The discs are then securely welded to support members, carefully ground and polished—*and each individual disc inspected four times*!

Precision is the Fansteel watchword in refining rare metals, designing and fabricating contact points under the close control of a laboratory staff of eminent metallurgists and engineers.

Fansteel—the source of supply for the best type of contact points—also rare metals and alloys in commercial forms. Our research laboratory is at your service.

CAESIUM · MOLYBDENUM · TUNGSTEN · TANTALUM · RUBIDIUM

FANSTEEL PRODUCTS
COMPANY, Inc.
NORTH CHICAGO, ILLINOIS

Transmitting Torque by Press Fits

(*Continued from Page* 46)

A number of factors affect the coefficient of friction between the fit surfaces, and among these the most important are the finish of the surfaces, the roundness of bore and shaft, the straightness or taper of bore and shaft, and, in the case of a press fit, the lubricant.

After a shaft is pressed into a hub, the lubricant in time tends to squeeze out and the metal surfaces to freeze together, and a greater force will be required to press the shaft out if the fitted parts are allowed to stand for several days. A greater force will be required also to press a shaft out of a ring that has been shrunk on than if a press fit has been made with the same allowance.

A general average of the coefficients of friction realized when pressing in shafts probably would be in the neighborhood of 0.15. For pressing out shafts the coefficients are somewhat higher than for pressing in, and for twisting the shafts in the fits the values are greater still. Therefore, in the determination of the torque that a press fit will transmit and the force that should be required to press the parts together, it is reasonable to use a value of 0.10 for the coefficient of friction in torsion and 0.075 in making the fit.

Since the torque that the fit is capable of transmtiting depends on the coefficient and the area of the fit surfaces in contact, this torque may be expressed as

$$T = \frac{\pi}{2} f PLd^2 \quad \text{.....(9)}$$

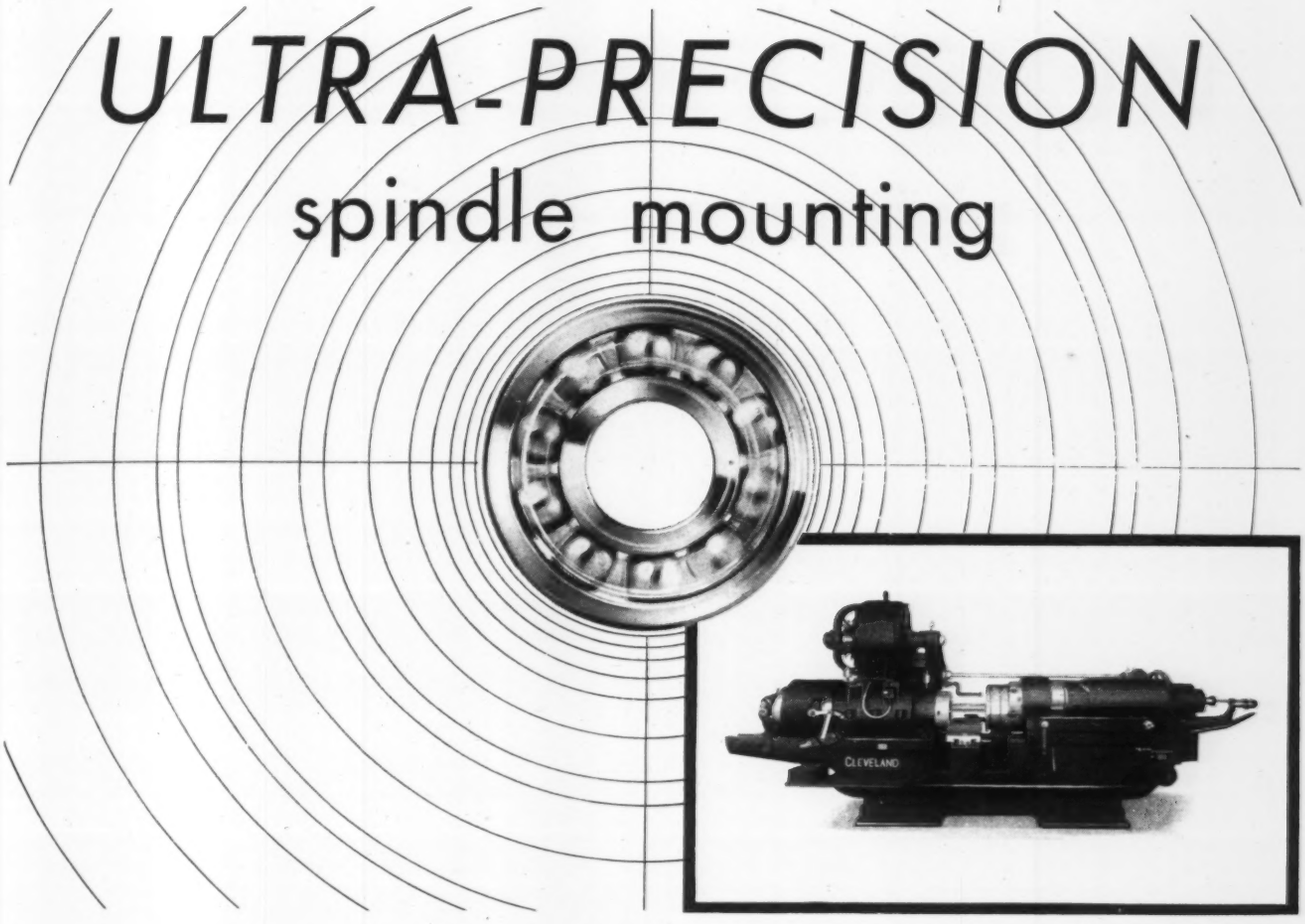
where T is the torque in pound-inches, f is 0.10 for a press fit and 0.125 for a shrink fit, P is the pressure obtained from Fig. 3, L the actual length of the fit, and d the shaft diameter. While it is fairly certain that the values suggested for f are conservative, they are based largely on coefficients realized in pressing shafts and hubs together; consequently, it is advisable to allow a safety factor in equation (9).

In a similar manner the average force in tons required to force the parts together is

$$F = \frac{\pi}{2000} f_1 PLd \quad \text{.....(10)}$$

In this equation 0.075 may be used as an average value or f_1. Values of f_1, however, may vary from a minimum of about 0.05 to a maximum of about 0.30, so that the tonnage also will vary within wide limits. P, L, and d are the same as for equation (9), and it will be observed that the force of pressing is in direct proportion to L, the length of the fit. In case a key has been used, the area πLd must be reduced by the area of the keyway.

ULTRA-PRECISION
spindle mounting



on wear-proof *FAFNIRS*

ACCURATE, rapid machining—that's what users of Cleveland Automatics expect and get. Spindles always run true—never need adjustment—they are mounted on wear-proof Fafnir Ball Bearings. And all the other vital parts throughout the machine are likewise maintained in perfect alignment (in some automatics as many as 74 Fafnir Ball Bearings being used). Day after day the Fafnirs whirl silently and friction free. The deep races and maximum number of large diameter balls provide positive protection against every load at any speed. They are of tough alloy steel and hardened throughout (not merely case hardened).

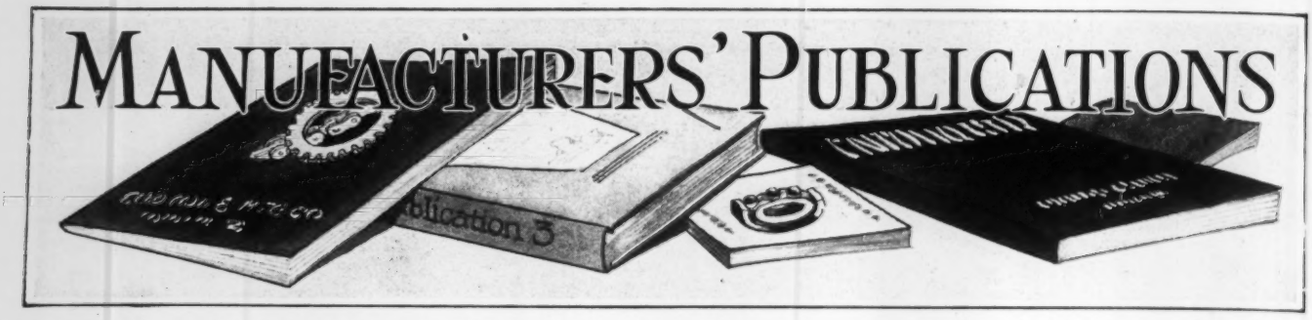
Accuracy in manufacture is reflected in the flawless mountings which Fafnir Ball Bearings are providing for America's leading machine tool builders. They know it pays to specify "Fafnirs throughout."

THE FAFNIR BEARING COMPANY, NEW BRITAIN, CONNECTICUT

Atlanta Chicago Dallas Milwaukee Detroit Newark Cleveland Philadelphia New York

FAFNIR
BALL BEARINGS

MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

WELDING—Beginning with the January issue, "Oxy-Acetylene Tips," published by Linde Air Products Co., New York, made its appearance as a standard size magazine with an entirely different format. During the eight and a half years of its existence the make-up of the publication has been improved consistently. Larger pictures are being used to illustrate the text and the editorial policy of presenting the latest information on developments in the oxyacetylene industry will be maintained.

MOTORS—Slip ring motors is the subject of an 8-page bulletin No. 169 recently issued by Wagner Electric Corp., St. Louis. The publication discusses in detail the mechanical and electrical characteristics of these units, their ability to start smoothly with low current draw when starting heavy loads, the four different types of slip ring motors, their speed torque characteristics and control equipment necessary for starting these four types.

VALVES—Duriron Co. Inc., Dayton, O., illustrates in a folder its new line of alloy steel valves designed for high pressure and high temperatures and the transmission of corrosive liquids and gases. Illustrations, diagrams and tables of dimensions cover all points in construction and operation. Split flange pipe fittings are also described and illustrated.

ALLOY IRON—Patterson Foundry & Machine Co., East Liverpool, O., has issued a leaflet on its K/A alloy, a product of the electric furnace. It possesses great strength and toughness, uniform structure, low sulphur and phosphorus and great resistance to abrasion and corrosion.

SCREW PRODUCTS—Union Screw & Mfg. Co., Pittsburgh, has issued a catalog with list prices on cap and set screws, nuts, studs and other products. It also contains tables of standard thread sizes, weights of steel and brass bars, net discounts and other data.

ELECTRICAL EQUIPMENT—General Electric Co., Schenectady, N. Y., recently released a number of bulletins on equipment including: solenoid-operated field switches; thermostats; totally enclosed, fan-cooled induction motors and relays.

ARC WELDING—An 80-page booklet on electric arc welding recently was published by Hobart Bros., Troy, O. It is logically arranged, conveniently indexed for ready reference and contains essential facts covering the successful application of arc welding to practical work.

VULCANIZED FIBER—Formed into sheets, rods, and tubes this material can be used for insulation, clutch linings, gears, rings, bushings, pulleys, pinions, and machined into scores of other parts. A descriptive bulletin presenting the properties, the manner in which vulcanized fiber is made and how it is used, is published by Continental-Diamond Fibre Co., Newark, Del. Useful tables and other products also are given in addition to the above data.

BELTS—L. H. Gilmer Co., Tacony, Philadelphia, has issued a bulletin on its endless woven fabric belts for high speed use on machinery and small pulleys.

MOTORS—Master Electric Co., Dayton, O., has prepared a booklet on the specifications, capacities and prices of its line of motors. The booklet includes a description of the equipment, and presents suggested applications.

STOP-NUTS—Technical data on the use of elastic stop-nuts intended for fastenings that require the nut to stay locked in any position along the threaded length of the bolt is presented by the Aga Co., Elizabeth, N. J.

ELECTRICAL ACHIEVEMENTS—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has compiled a record of its engineering achievements in the field of electricity in 1930, illustrated and each item described.

SET-SCREWS—Shakeproof Lock Washer Co., 2501 Keeler avenue, Chicago, has issued a circular illustrating and describing the new Shakeproof self-locking set screw which is so designed that it cannot shake loose.

HAND TAPS—Bristol Co., Waterbury, Conn., has issued a booklet on the hand taps necessary to tap holes for insertion of Bristo-Dardelet self-locking cap and safety set screws, employing the Dardelet screw thread.

MEEHANITE METAL—A metal of great strength and toughness which can be cast in any form is described by the Dodge Mfg. Co., Toronto, Canada. Characteristics and physical properties of the material are given.

MOTORS—Leland Electric Co., Dayton, O., recently issued a bulletin describing its repulsion induction, cradle mounted, sleeve bearing motor. Features of design include isolation of torque oscillation and rotor vibration. The unit is designed for application where quiet operation is considered imperative, particularly in electric refrigeration and oil burners.

PNEUMATIC PRODUCTS—Carl A. Norgren Co., Denver, division of the Commercial Instrument Corp., has issued a catalog covering various devices for use in connection with pneumatic lines, including regulating and reducing valves, diaphragm relief valves, strainers, water

DIETZGEN

A COMPLETE LINE

from ONE RELIABLE SOURCE

DIETZGEN
ESTABLISHED 1885

DIETZGEN is the choice of thousands of Industrial Plants, Schools, Architects, Engineers for

Cross Section Papers
Celluloid Curves
Drawing Boards « Drawing Inks
Blue Print Papers
Pencils « Pens
Ink Bottle Holders
Drawing Instruments
Drawing Papers « Triangles
Scales « Slide Rules
T-Squares « Thumb Tacks
Tracing Cloths
Scotch Holdfast Drafting Tape
Tracing Papers
and scores of other items included in the DIETZGEN Line

UNIFORM QUALITY—RIGHT PRICE —PROMPT DELIVERY

Write today for descriptive literature on any or all of these items

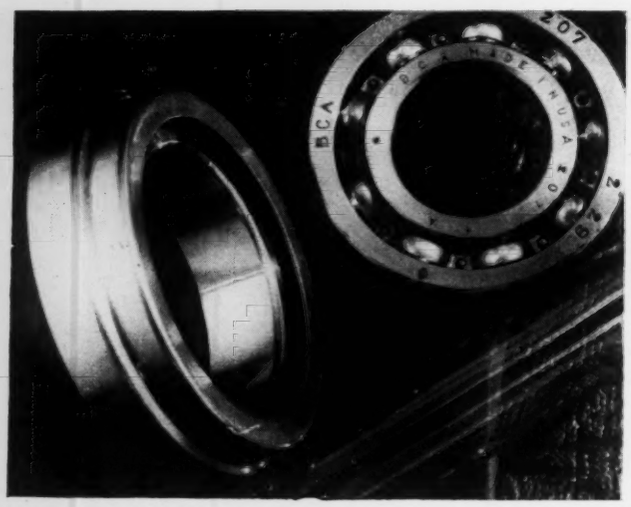
EUGENE DIETZGEN CO.

Enduring worth at reasonable cost

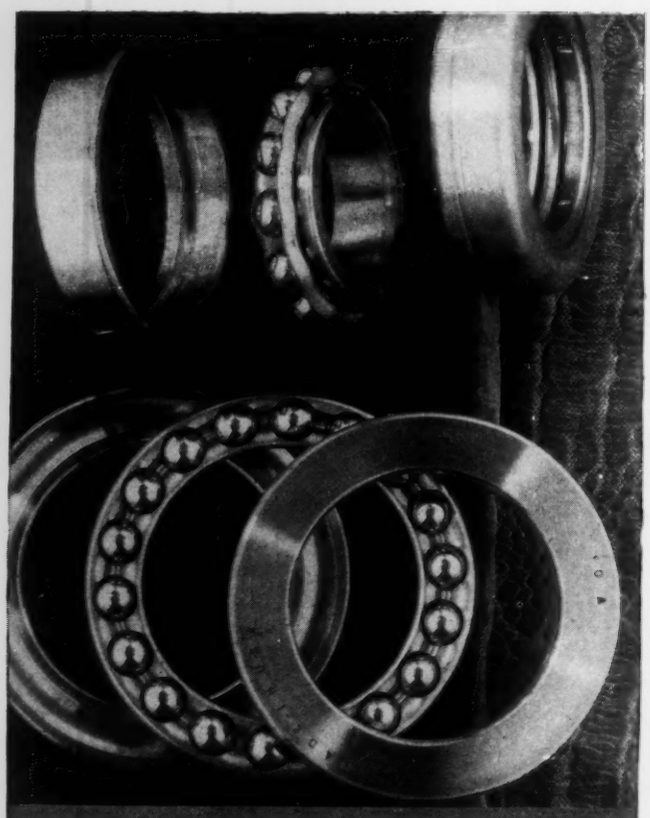
Chicago · New York · New Orleans · Pittsburgh · San Francisco · Philadelphia · Washington · Milwaukee · Los Angeles
Factory at Chicago

DIETZGEN
ESTABLISHED 1885

Manufacturers of Drafting and Surveying Supplies



Modern design, tending toward extremely compact, light-weight construction, frequently combined with high loads and speeds, is developing new uses for precision ball bearings. Our mechanical engineers, experts in anti-friction and bearings problems, are at the call of those machine designers who can benefit by such specialized advice. Write to us.



BEARINGS COMPANY
OF AMERICA
LANCASTER, PA.
DETROIT MICH. OFFICE: 1012 FORD BLDG.

pressure governors, air line lubricators, sight feed vertical lubricators, blow valves, couplings, clamps and accessories.

PHOSPHOR BRONZE—History, composition and uses of the material including the forms in which it is available is given in a booklet issued by Riverside Metal Co., Riverside, N. J. Laboratory services available, information on alloys, and general data is included.

LOOM MOTORS AND CONTROL—Latest designs of loom motors and their distinctive features are described in a publication of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The control used for this motor is the Westinghouse Motor Watchman.

BELT DRIVES—Specifications for standard short-center flat belt drives from one to 50 horsepower are presented in booklet form by Rockwood Mfg. Co., Indianapolis. The booklet is made up largely of specification tables, with illustrations of applications to various types of machinery.

HOSE ASSEMBLIES—J. N. Fauver Co., Detroit, manufacturer of lubrication systems and equipment, presents in a current bulletin the claims of its rubber hose assemblies for machinery and machine tools. They are designed for hydraulic assemblies, lubricating assemblies, and cooling systems.

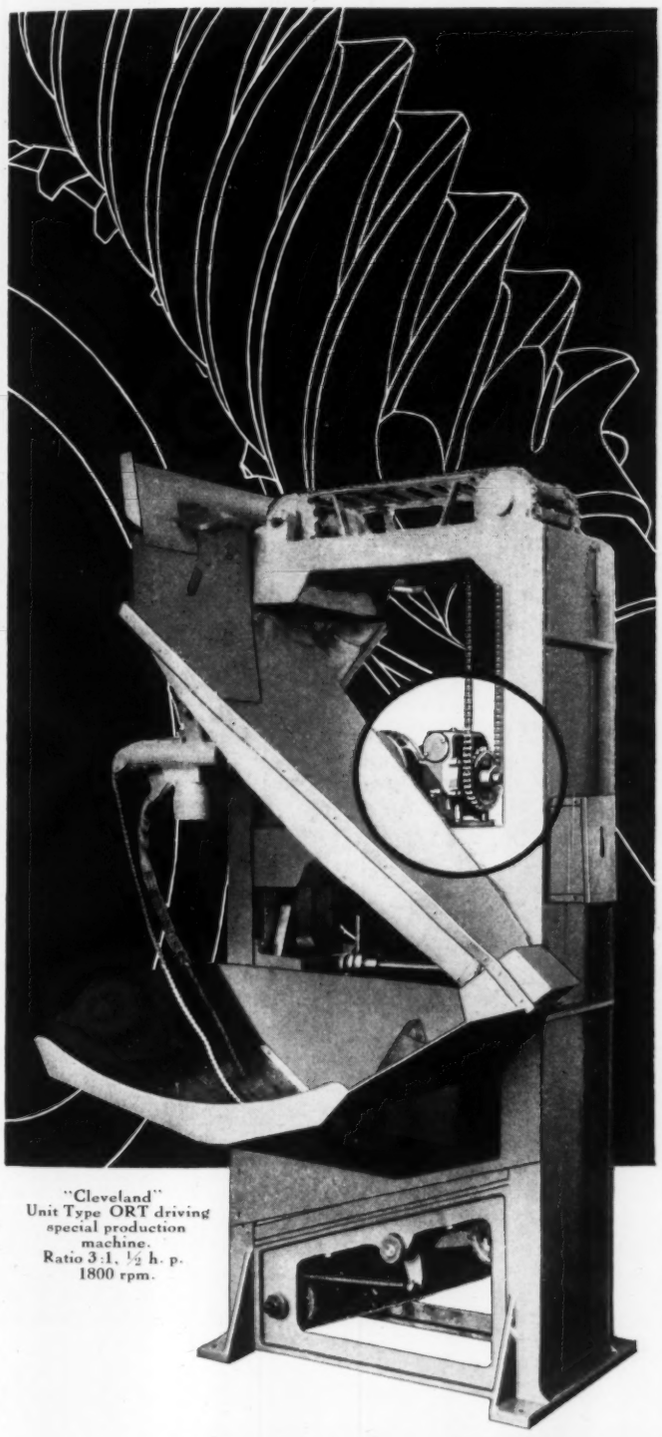
SPRINGS—Complete data sheets on compression-type springs available from stock is prepared in convenient folder form by Hardware Products Co., Boston. The sheets include description, dimensions, specifications, loads carried, maximum deflections, solid heights and similar information.

STEEL PRODUCTS—The third general catalog covering steel products manufactured by Moltrup Steel Products Co., Beaver Falls, Pa., recently was placed in circulation. Cold drawn steel and alloys, shafting, woodruff keys, finished machine keys, etc., are characteristic of the items discussed in the text.

WELDED CONSTRUCTION—A 19-page booklet on Lukenweld construction, a fabricated product obtained by welding Lukens rolled steel, recently was issued by Lukenweld Inc., Coatesville, Pa. This method of manufacturing units such as housings, bases, beds, gear cases and other parts of machinery and equipment, is discussed in detail. Illustrations supplement the text.

PUMPS—Vickers Inc., Detroit, has issued a booklet on its V-type rotary pumps for hydraulic control systems. Performance curves and dimension charts give accurate data on the results which may be 'expected and the mounting space required for these pumps, while the booklet also includes a description of the pumps, operation and hydraulic data, and information and order numbers for parts required.

Designers specify this speed reducer because it's so *simple* . . . . .



"Cleveland" Unit Type ORT driving special production machine. Ratio 3:1, ½ h. p. 1800 rpm.

In designing your own machines, you strive for simplicity. You know from experience that the simplest machine lasts the longest, gives more dependable service, and costs less to maintain.

The same principles apply to speed reducers.

That is one reason why hundreds of designers stoutly insist that "Cleveland" Worm Gear Units be used on their equipment. No other type of speed reducer contains so few moving parts. For reduction ratios up to 100:1 only one worm and one worm gear are necessary.

There are no complicated arrangements of gears and meshing surfaces. Every part is immediately accessible. Proper lubrication becomes a simple matter. Maintenance and repairs are almost negligible. "Nothing expended in eight years," a Massachusetts firm writes. And from another, "We feel confident that our 'Cleveland' drives will give 10 years service without any repairs."

High quality materials, precision workmanship and conservative rating all contribute to such performance but in large measure it is due to "Cleveland's" inherently simple design. Data and information for fitting "Cleveland" Worm Gear Speed Reducers to your machines are given in Bulletins 108 and 110. The coupon below will bring them to you without obligation.

CLEVELAND
WORM & GEAR COMPANY
3275 EAST 80TH STREET . . . CLEVELAND, OHIO
CLEVELAND WORM GEARING . . . THE ULTIMATE DRIVE

Kindly send me Bulletins 108 and 110 containing data and information on your worm gear speed reducers. No obligation.

Name_____ Company Name_____

Address_____